A Tale of Two Citizens: How South Africa's Most Visible Scientists Use Twitter to Communicate with the Public

by

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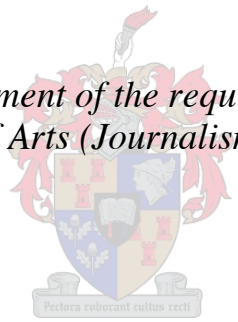

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Declaration

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Abstract

In an age that is often described as being both the best and worst of times for communication, it is becoming increasingly important for science to be as decentralised as possible. One of the ways to achieve this is for scientists to make an effort to communicate and engage with other scientists as well as members of the general public. This can be facilitated via a variety of modern information communication technologies and applications such as social media. However, since there is no exact or specific formula for how to communicate on social media platforms like Twitter, some scientists are hesitant to get involved. For this reason, scientists can and should benefit from other scientists who have experience on social media, especially those who have been criticised in a public way. Therefore, this study examines how two highly visible and controversial South African scientists – Lee Berger and Tim Noakes − use Twitter to communicate with their diverse publics, despite pressure from other scientists and social media users. One hundred tweets published by Berger and one hundred tweets published by Noakes before and during periods of controversy has been collected and analysed in order to make sense of the online communication strategies of these prominent scientists.

Keywords: science communication, social media, controversy, strategy, public engagement, visibility, Twitter

Opsomming

In ‘n era wat gereeld beskryf word as die beste en slegste van tye word dit toenemend belangrik vir desentralisasie van die wetenskappe. Een moontlikheid vir die bevordering hiervan is vir wetenskaplikes om ‘n poging aan te wend vir kommunikasie met ander individue binne die wetenskapsveld en met die algemene publiek. Dit kan gefasiliteer word deur ‘n verskeidenheid inligtingskommunikasietegnologieë en toepassings soos sosiale media. Siende dat daar egter geen spesifieke of vasgestelde formule vir komunikasie op sosiale media platforms soos Twitter is nie, huiwer sommige wetenskaplikes om betrokke te raak. Wetenskaplikes kan en moet dus leer by ander individue in die wetenskap met ervaring op sosiale media, veral diegene wat al blootgestel was aan openbare kritiek. Daarom ondersoek hierdie studie hoe twee sigbare en kontroversiële Suid-Afrikaanse wetenskaplikes – Lee Berger en Tim Noakes – van Twitter gebruik maak om met hulle diverse publiek te kommunikeer ten spyte van druk vanaf ander wetenskaplikes en die publiek. Een honderd twiets van Berger en een honderd van Noakes voor en gedurende tye van omstredenheid is versamel en ontleed om sin te maak van die kommunikasiestrategieë van hierdie prominente wetenskaplikes.

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Chapter One: Introduction

1.1) Background

> "There comes a time in our lives when we first realise we are not the centre of the universe, that we belong to something much greater than ourselves; it's part of growing up and as it happens to each of us, so it began to happen to our civilisation in the 16th century" (Cosmos, 2014).

"Imagine a world before telescopes when the universe was only what you could see with the naked eye…" begins Neil deGrasse Tyson in the first episode of Cosmos: A Spacetime Odyssey − the 2014 remake of the Carl Sagan classic (Cosmos, 2014). deGrasse Tyson guides viewers through a narrative detailing the early days of astronomy and then refers to examples of people from the past that played a role in shaping science as we know it today. One of these key individuals is Giordano Bruno, a "well-known martyr to the cause of modern astronomy" (Powell, 2014), who lived at a time when challenging the ideas of the Catholic Church was considered a crime punishable by law. He argued in favour of Copernicus' theory that the sun is the centre of the universe and also proposed that space, and therefore God, was infinite. Bruno was exiled for his belief until he was eventually imprisoned by the Church and burned at the stake in 1600, only 10 years before Galileo announced that his observations confirmed Copernicus' theory (Cosmos, 2014). Similarly, Galileo went on to be accused of being a heretic because he challenged the word of God, as interpreted by the Roman Catholic Church (Cosmos, 2014). He too was punished for his work but managed to inspire what has now come to be known as the Scientific Revolution. Of course, Bruno and Galileo are not the only two individuals that swam against the conventional current. There are many more thinkers, from all parts of the world that played a role each contributing to the scientific method that continues to be the backbone of modern science.

The main insight and recurring theme provided by and evident in these kinds of narratives concerning the history of science is that there has always been a conflict between authority and those who have dared to challenge the status quo (Cosmos, 2014). But that despite this conflict, scientists have been determined to communicate directly, or via other channels, with the public. According to Gallo (2012:1), "a conflict is a special kind of system whose complexity stems from many different and sometimes unrelated elements." Conflict can arise even at an individual level; a dilemma, wherein one party has to choose from a variety of options. This is the simplest form of conflict to observe as there is only one individual to study. However, when two individuals are involved in a conflictual situation, it becomes more challenging to make sense of the intricacies of the relations between the two parties. Thereafter, it is also a challenge to make sense of their individual and diverse objectives in relation to other factors − including how each individual interacts with other external systems. This means that there can be interactions and then "interactions among interactions" as well (Byrne, 2001:20).

1.2) Decentralisation

Over the past century, there has been a shift from scientists working in isolation towards scientists choosing to adopt a more inclusive and transparent system by interacting with society via traditional as well as social media (Joubert & Guenther, 2017). Communication between scientists and their diverse publics is considered to be a key feature of a democratic knowledge or information society, which is why it is important for the communication to be as effective as possible. However, as science becomes more visible it also becomes susceptible to political agendas that lead scientists to compete for attention and support. Joubert and Guenther (2017) suggest that the reasons why scientists might be motivated to be visible in the public sphere are both diverse and complex. For this reason, this study will be based on an analysis of two South African scientists that are considered to be highly visible in the public eye, Lee Berger and Tim Noakes, because they strategically make use of traditional and digital media platforms to participate in public science communication (Joubert and Guenther, 2017). Due to the fact that there are a variety of traditional and digital media platforms to choose from, this study will focus on how Berger and Noakes use Twitter to communicate science with their diverse publics.

1.3) An Online Public Sphere

Twitter is a microblogging platform that averages around 336 million users per month (Twitter: number of monthly active users 2010-2017, 2017). It is a popular way to share information and enhance communication between users that are located all across the globe (Holmberg & Thelwall, 2014). What makes Twitter unique is the fact that users are restricted to posting individual tweets comprising of up to 280 characters alone. Other features include retweets (RTs), which allow users to repost tweets from other users on their own profile (Holmberg & Thelwall, 2014). Hashtags (#) are also used in front of keywords or phrases in order to organise tweets that are based on similar topics so that users can search for them with ease. Twitter is considered to be useful when it comes to in-the-moment/live conversations concerning real-world topics, opinions, and interests (Bik & Goldstein, 2013). It is also a social platform with news feeds that can be customised according to the users' preferences, which means a variety of online communities can be built and maintained (Bik & Goldstein, 2013).

1.4) Controversy

Besides being deemed highly visible, Berger and Noakes as scientists are also considered to be controversial; a factor that is often responsible for leading to increased public visibility, whether the individual is actively participating or not (Joubert and Guenther, 2017). Although Berger was born and raised in America, he has been living and working as a paleoanthropologist in South Africa for over two decades. In 2015, Berger made international headlines when he announced the discovery of an entirely new human species called *Homo naledi.* According to a report by *Scientific American* (Wong, 2016), 1 550 specimens representing at least 15 different individuals were recovered over a period of a few weeks of excavation from the Rising Star Cave system, which

is located near Johannesburg. Besides offering audiences an explanation for how the remains must have ended up in this particular cave, Berger and his team suggested that this primitive species might have deliberately disposed of its dead in the cave; behaviour that most experts consider to be limited to species with superior intellectual capacity, such as our own *Homo sapiens* (Wong, 2016).

Since the fossils were announced, the discovery has been embroiled in controversy. Some scientists argue that the bones are not new and instead belong to an already known species called *Homo erectus*. Others are critical of Berger and his team member's suggestion that the remains must have been the result of a deliberate burial as well as his inability to accurately date his findings (McKie, 2015). However, the primary criticism against the *Homo naledi* find is centred in the manner in which Berger revealed his work to the world. He was accused of being in a hurry to publish his findings so that he could please the media; an irregularity in the field of palaeontology as it usually takes experts years to study a skeleton in isolation before finally publishing their findings in a respectable journal that is peer-reviewed (McKie, 2015). Some even claimed Berger's theory was "racist pseudoscience" as it was perceived to show that Africans were subhumans (Joubert & Guenther, 2017:7). However, during a press conference in May 2017, Berger and his team substantiated the original theory by announcing that many other fossils had been found. They were also able to provide dates for the fossils and argued that this species could have shared certain cognitive traits with modern humans, including hands that were able to make and then manipulate tools.

Similarly, Noakes' decision to shift from promoting a high carbohydrate diet to a low carbohydrate high fat (LCHF) diet resulted in what Joubert and Guenther (2017:7) describe as a "diet war" between Noakes' supporters − who are mostly members of the general public − and critics, who are mostly from the scientific community. Noakes obtained his MBChB degree from the University of Cape Town (UCT) in 1974, an MD in 1981 and a DSc (Med) specialising in Exercise Science in 2002 (About Us: The Founder, 2018). According to Noakes' research, a low carbohydrate, high fat (LCHF) diet is the healthiest option for many people, which is why he promotes it. Despite being received by overwhelming popularity and media-attention, Noakes was criticised by his peers in an open letter that was published in 2014. In this letter, penned by the then Dean of the Faculty of Health Sciences at UCT, Professor Wim de Villiers, and three other colleagues, Noakes and supporters of the LCHF "revolution" were criticized for promoting a diet that makes "outrageous and unproven claims about disease prevention" (de Villiers, Mayosi, Opie and Senekal, 2014:1). De Villiers *et. al.,* (2014:1) argued that Noakes was at fault for not conforming to "tenets of good and responsible science" that is based on evidence and reviewed by peers. In 2014, former president of the Association for Dietetics in South Africa (ADSA), Claire Julsing-Strydom, accused Noakes of unprofessional conduct when he gave "unconventional advice" via Twitter (Spence, 2018), which was addressed in a hearing with the Health Professions Council of South Africa (HPCSA). After being found not guilty, the HPCSA decided to appeal the verdict and a second hearing was held in 2018. Two months after the appeal, Noakes was found not guilty once again (Spence, 2018).

However, despite winning the disciplinary hearings Noakes had to endure years of criticism that put a huge strain on himself and his family (Joubert & Guenther, 2017).

1.5) Purpose, Aims and Motivation

While this topic has many layers, the purpose of this particular study is not to determine whether Berger and Noakes' theories are the truth or not, as neither scientist was found formally guilty of scientific misconduct or pseudoscience. Instead, this study is based on Joubert and Guenther's (2017) insight that controversies such as the ones experienced by Lee Berger and Tim Noakes might make other South African scientists hesitant to share their findings with the public. Therefore, the aim and motivation of this study are to make sense of how Berger and Noakes handle criticism and cope with controversy via the social media platform Twitter so that other scientists can learn from their experiences.

1.6) Problem Statement

The aim of this thesis is to examine how South Africa's two most visible scientists, Lee Berger and Tim Noakes, use Twitter to directly communicate with the public.

1.7) Research Questions

- What kind of language and tone do Berger and Noakes use when communicating via Twitter?
- How do Berger and Noakes connect and communicate with their audiences, including critics?
- Is there evidence that one or both of the studied scientists' history with controversy have influenced their style of communication on Twitter?

The concepts briefly mentioned in this introductory chapter shall, henceforth, be described in more detail in the literature review chapter that follows.

Chapter Two: Literature Review

In this chapter, all literature that is relevant to the topic shall be outlined and critically engaged with and discussed.

2.1) Science and Society

Towards the end of the Renaissance, Italian polymath Galileo Galilei invented a telescope and used it to look up at the sun (Shapin, 1996). With this tool he was able to observe dark spots on the surface of the sun, leading him to the conclusion that, contrary to popular belief, the heavens might not be so perfect after all. As can be expected from a hyper-religious era, Galileo's hypothesis was rejected by the Catholic Church because he dared to challenge their accepted beliefs concerning the fundamental structure of nature. Simultaneously, he also upset the delicate balance of 17th century Europe by choosing to publish his findings in Vulgate rather than Latin, so that more people would be able to understand the information he was sharing (Musil, 2006). Galileo was persecuted for embracing empiricism but his efforts were not in vain, as he is now recognised as being the first science communicator and has been given credit for being part of what has now come to be known as the Scientific Revolution (Shapin, 1996).

The long-term consequences of Galileo's defiance were that it shook the very core of traditional thought-structures (Magee, 2016). When it came to matters of truth-seeking, people started to become critical of authority, refusing to believe the information presented to them without asking questions and demanding evidence. Ultimately, the Catholic Church lost its control over the intellectual and cultural life of Europe (Magee, 2016). In its place, different social, intellectual and cultural movements were conceived; forming part of the Public Sphere. The Middle Ages had officially been replaced by the Age of Enlightenment; an era devoted to reason above all else. Interestingly, Aristotle's epistemology was also rejected during this time as Aristotle was considered to be a figure of authority, and therefore someone who could not be trusted (Magee, 2016). However, his empiricism was not lost forever as followers of his work and supporters of his method continued to formulate new theories that would later be referred to as positivism.

2.2) The Public Sphere

The public sphere is an area of social life that allows different citizens to come together to discuss a variety of relevant topics and issues that could influence political policies and activities. For this reason, it is a vital component of modern society that has attracted the attention of numerous scholars that have tried to formulate normative theories about how the public sphere should be structured in order to fulfil its role (Gerhards & Schafer, 2009). German sociologist Jurgen Habermas' participatory model is perhaps the most well-known theory concerning how the public sphere should function. According to the participatory model, public communication should include a range of topics and arguments that strive to include as many people as possible. It also emphasises that there are two types of actors; 1) the media and 2) politicians that must be present in a

democratic public sphere and that communication between all participants should be open and free. However, it is important to note that the participatory model is normative, which means a theory that focuses on how things should ideally operate. This does not guarantee or change the reality that issues will not always be presented and interpreted in the same ways. Participants or actors − including the media and politicians − use 'frames' to package and also make sense of information (Gerhards & Schafer, 2009). A frame can influence how an issue is defined and thereafter, whether or not it will be considered a problem that needs to be addressed and how. Therefore, a frame can be a limiting factor as it excludes certain viewpoints and perspectives (Gerhards & Schafer, 2009).

Before continuing, let us define and clarify what is meant when referring to an expert, as it is a term that is often used to describe a public intellectual. According to Lightman (1999), there are three different types of public intellectuals; the first who speaks and writes exclusively for the public about an area/discipline that they have expert knowledge about, the second who speaks and writes about a specific field in relation to how it impacts the social, cultural and political aspects of society, and the third who represents more than an authoritative voice but rather a symbol much greater than themselves. The common thread evident in all three types, however, is that public intellectuals are publicly visible; a concept that will be explored later on.

2.3) Science Popularisation

Massarani and de Castro Moreira (2004:75) argue that the scientific revolution of the 17th century can be considered the start of "systematised scientific activities." By this they mean that science became popularised; blurring the social distinction between science and public, which had once been kept separate by the Catholic Church. Science became institutionalised and society started to recognise a scientific community that had its own set of standards and rules. In the following century, books about physics, electricity, and other experiments caught the eye of the aristocracy and middle classes. There was finally a growing audience that was interested in learning more about science. Similarly, the invention of the steam-powered printing press made it cheaper to print more pages per hour. When this happened, the lower classes were able to afford to buy informative texts, thus expanding the audience for scientific-related media and communication. The popularisation of public science via the mass media was not only a good thing for the general public, it was also a catalyst for improving science communication within the scientific community as well (Massarani & de Castro Moreira, 2004:75).

2.3.1) Einstein

Even though Albert Einstein's fame might be taken for granted today because the term 'Einstein' has become a part of modern speech used to describe a person of great intelligence, it took many years before the scientist himself was actually recognised outside of the scientific community (Krauss, 2015). In 1905, Einstein developed the theories of Special Relativity and General Relativity, as well as the foundations of quantum mechanics. He changed the way that people would think about the relationship between space and time and matter and

radiation. However, it was only in 1919 that Einstein's name was discovered by a team of researchers from Britain who wanted to test his ideas whilst on an expedition to South America. Later that year Einstein appeared on the front page of *The New York Times*; a momentous occasion, as it was not normal for scientists to be given so much media attention. After being published on the cover of newspapers, his opinions began to matter to people outside of the scientific community as well. Krauss (2015:28) refers to Einstein as the "first modern A-list scientific celebrity" because everything he said was soaked up and then spread by the media. Although most laypeople could not comprehend the magnitude of Einstein's work and what it meant for the future of science, he was revered by the public. Particularly because his appearance was that of a "bemused and playful grandfatherly type, with a spark in his eye, an amusing quote at the ready, and an old-world German accent," which resonated with the public (Krauss, 2015:28).

2.3.2) Feynman

Unlike Einstein who became famous shortly after publishing his groundbreaking research concerning relativity and quantum mechanics, American theoretical physicist Richard Feynman did not achieve fame for his scientific accomplishments. Instead, Krauss (2015:28) explains that although Feynman had a "colourful personality" and tons of charisma, he only received recognition after a series of books based on narratives that he had shared orally, became bestsellers. Upon the publication of *Surely, You're joking, Mr Feynman!* In 1985, Feynman quickly grew in popularity and even reached "popular cult hero" status (Krauss, 2015:28).

2.3.3) Sagan

American astronomer and cosmologist Carl Sagan is considered to be the first scientist to be as "recognisable to the average person as most TV or movie stars" because he himself was also a TV star (Krauss, 2015: 29). Sagan was the host of the most watched public TV series of all time, Cosmos: A Personal Voyage, which was produced in 1978 and 1979, and cost $6.3 million. It was the first television documentary to use videotape and therefore, had special effects too. He regularly appeared on late night talk shows, including the Tonight Show Starring Johnny Carson, that helped boost his public profile. However, Sagan did not only use the media for his own personal gain. He also used his platform to act as a voice for science, often speaking out against social issues such as the possibility of a Nuclear Winter or even how religion and other superstitions could pose a threat to society. Krauss (2015) suggests that Sagan's ability to manipulate the media in order to be a public advocate for science, made him more respected by members of the public rather than by many of his scientific peers. Some felt that Sagan's reputation did not match up to his scientific contributions, which led to feelings of jealousy. However, Sagan's efforts in public science education were later acknowledged when he received the National Academy of Sciences' award for public service (Krauss, 2015).

2.3.4) deGrasse Tyson

Following in the footsteps of Sagan, Neil deGrasse Tyson was the host of the remake of Cosmos: A Personal Voyage called Cosmos: A Spacetime Odyssey, which aired in 2014. While the remake might not have impacted

the original series, Krauss (2015) argues that it played a role in increasing Tyson's popularity in the public sphere. Krauss (2015) also highlights the fact that, unlike the other three scientists mentioned already, Tyson did not pursue a traditional research career. After receiving his PhD, Tyson joined the Hayden Planetarium, which he used as the base to communicate science. Indeed, having credibility within the scientific community can make it easier to "reach out beyond the walls of academia" (Krauss, 2015:30) but scientists such as Tyson are examples of science communicators who are doing whatever they can in order to communicate science with the public in an accessible manner.

2.4) The Information Society

Today, centralisation of knowledge is no longer as much of a concern as it was before the turn of the century. This is because we have entered the Age of Information, otherwise known as the Information Society, Network Society, Digital Society, Virtual Society and Information Communication Technology (ICT) Society (Fuchs, 2012). Described by Raban, Gordon and Geifman (2011:375) as a "brief and modest way of expressing a very elaborate concept," which is why scholars - from both the natural and social sciences - have spent the past few decades trying to define the Information Society from different angles. Webster (2002) suggests that there are four features that are unique to the Information Society, namely technological change, economic value, information flows, and the expansion of signs and symbols. However, he argues that ICTs are the greatest indicators of "new times" as they permeate and dictate the course of our daily schedule in ways that we would once have not been able to imagine 50 years ago.

Since the introduction of the Internet and rise of accessible ICTs in the 1980s, people have been able to enjoy an ever-increasing level of decentralised information that would not have been possible without globalisation. In this context, globalisation refers to a social process that involves citizens from all over the world (Fourie, 2015). These people do not have to know each other in real life but all share one thing in common: they are affected by "disembedded organisations" (Giddens, 1999 in Fourie, 2015). This means that people are now able to interact with organisations, even though they do not occupy a fixed place. Therefore, disembedded organisations can be local or international as well as financial, political, cultural, governmental or educational in nature. The primary feature of a disembedded organisation is that it exists to provide consumers with different types of informative, educational, or entertaining content. Their aim is to equip the public with knowledge that will help them understand the world around them, in a way that would − in the past − only be possible by physically travelling to various locations and meeting with different people in person. For this reason, Holmes (2005) and Adrian (2012) stress the importance of ICTs, as new technologies and global connectivity have established a two-way communication between the elite sources − who used to have sole access to information − and the general public, who rely on information to make individual and collective decisions. The steady growth of technology is transforming the quality of content being produced as more and more producers compete for audiences' attention.

However, even though we are living in what has been called the Age of Information or Information Society (Fuchs, 2012), the advantages of free-flowing information cannot be actualised unless there is functioning infrastructure made available to all people wishing to participate online (Hanafizadeh & Yarmohammadi, 2015). This is not a reality for all people, especially those living in developing countries where the majority of the population is impoverished (Mbatha, 2015). Without fundamental infrastructure, education, and policies the developing world cannot enjoy the information society in the same way that someone from the developed world can (Elyakov, 2009).

Similarly, Golding (2000) argues that only the members of society that exhibit symptoms of post-materialism can enjoy the benefits of globalisation, the Internet and technology. Rooted in Maslow's theory (Naidoo, Townsend & Carolissen, 2011) about the human hierarchy of needs, a person can be said to have reached a state of post-materialism when they experience a sense of unprecedented peace, affluence, and stability − both personal and social. Once a person has achieved material security he or she are then able to refocus their attention on other needs, which can perhaps be described as the cherries atop what is otherwise a comfortable life. According to Golding (2000), these metaphorical cherries include being able to pay attention to matters concerning art, expression, and the environment.

While some of the concerns raised by critics are valid, Castells (2010) emphasises that the information technology revolution is more than an introduction of new products. In his view, all technological revolutions have been about trying to change the status quo gradually over a period of time. He argues that ICTs are not just communication tools but also symbols of a new process that will take years to develop into a qualitative experience that can be enjoyed on a greater scale. In the past, people were limited to a centralised form of top-down, one-way communication. From the Middle Ages to the Age of Enlightenment, and then again in the 19th and 20th centuries, citizens had to rely on representative publicity controlled by various institutions - including the media.

As the information society continues to become increasingly decentralised, more information will begin to flow from the bottom-up and individuals with access to ICTs will be able to shape their own user experience (UX) online. This is why Castells (2010) does not believe that the information society is a threat to democracy. Instead, it gives a growing number of people a chance to participate in critical conversations in a diverse online media environment. Goodman and Light (2010) agree that social media platforms are sites of networked publics; the modern and technological equivalents of Habermas' normative public sphere, where citizens were free to communicate openly with one another.

Besides affecting the way that people communicate, the Internet has also changed the way that people identify as communities (Gruzd, Wellman & Takhteyev, 2011). Once limited to concrete social relationships that exist in a physical place, communities can now consist of imagined sets of people that are perceived to share certain qualities in common. These individuals need not have ever met in person as long as they are able to bond over the same things. Unlike concrete social relationships, imagined communities are born online and use social media to connect with like-minded users. On Twitter, for example, an individual can have hundreds of followers that they will never interact with outside of the digital realm. In essence, this platform allows people to feel bonded with strangers from across the globe.

2.5) Twitter

Twitter was launched in 2006 and became hugely popular in 2009. It is a social networking and microblogging service that allows users to create and consume short messages that are referred to as "tweets" (Gruzd, Wellman & Takhteyev, 2011). At the moment, Twitter averages approximately 336 million monthly users (Twitter: number of active monthly users, 2010-2018). It is a unique platform because it has a variety of special features, the main one being the character limitation imposed on tweets. Users or "tweeps" (Gruzd, Wellman & Takhteyev, 2011) were only able to make tweets that consisted of a maximum of 140 characters. As of November 2017, this rule changed and the tweet-length doubled to a maximum of 280 characters.

If tweep X chooses to forward a tweet that was posted by tweep Y then this tweet becomes known as a retweet (RT) as it was not originally created by the person sharing it. On Twitter, an @ symbol is used in front of a username so that tweeps can tag each other in tweets or direct messages (DMs). A tag occurs when one user mentions another user in a tweet. Hashtags (#s) that are placed in front of words or phrases, automatically group together any and all tweets that have these words or phrases in common. The purpose of a hashtag is to aggregate tweets according to topics (Holmberg & Thelwall, 2014). From a science communication perspective, hashtags can be applied in a variety of settings, especially conferences. Conference coordinators can create a specific hashtag and ask all attendees to use this particular hashtag at the end of all tweets so that they can be grouped together. If a hashtag becomes popular enough then it will be added to the "trending" list (Bik & Goldstein, 2013).

Another interesting feature of this microblogging service is that it is asymmetric. If user X follows user Y, user Y is not obliged to follow user X back. A mutual following will only occur if both user X and user Y follow one another. Users can check to see if someone is following them by clicking on a profile and seeing a "follows you" icon next to their username. Gruzd, Wellman, and Takhteyev (2011) refer to Twitter users as "tweeps" and suggest that they experience a dual-faceted community that is both communal and personal. Twitter is a communal experience as all tweeps belong to a collection of users who all understand the norms, languages, techniques, and symbols associated with this platform. Similarly, all tweeps' profiles and tweets are public,

except for those that choose the private option that locks the account from viewers who are not approved, followers. High-profile tweeps form the centre of the communal, collective community. Celebrities and media institutions tend to be the hub of Twitter. Simultaneously, Twitter offers a personal community that is shaped by tweeps who imagine that they are following and having conversations with other tweeps who they can relate to on some level. Even though celebrities and media institutions are considered to be the basis of the collective Twitter, Gruzd, Wellman & Takhteyev (2011) argue that less popular individuals can also be the centre of personal Twitter communities that are linked through mutual connections.

However, to a novice tweep or scholar trying to make sense of the platform, the intricacies of Twitter can be quite difficult to grasp because of the three levels of communication that occur at the same time: the macro level; which is visible to all people, even those without their own Twitter account. Then there is the meso level; which occurs when group conversations are facilitated by networks created by tweeps and their followers. Lastly, the micro level; which is evident in tweets that are directed from one tweep to another (Bruns & Moe, 2013 in Goodman & Light, 2016). It is important to note that a communicative exchange can occur simultaneously over several of these levels. In addition, a hashtag or the removal of an @username can also change the dynamics of a conversation (Goodman & Light, 2016).

2.6) Social Media, Scientists and Society

Science, too, has become increasingly decentralised over the past century (Joubert & Guenther, 2017). Instead of working in a closed system, scientists are choosing to embrace a more transparent system that allows for collaboration and teamwork. This is a positive thing for science and also an important feature of a democratic Information Society because it allows the public to remain informed about how the scientific community is spending the tax money they are allocated. However, even though decentralisation increases participation and engagement between scientists and diverse audiences, it also means that scientists have to compete for attention if they wish to remain relevant and continue to receive funding. Joubert and Guenther (2017) argue that this has led to science becoming politicised; a worrying trend that indicates the re-emergence of a dependency between science and authority, which was fought so hard to be dismantled in the past.

2.7) Motivators to communicate science

There are different ways to communicate science with the public (Bultitude, 2011). These ways can be broadly categorised into three groups; face-to-face events, traditional journalism, and online interaction. The first type, face-to-face events, refers to the direct interaction between scientists and the public that was triggered by the likes of Galileo in the past. It is a personal style of communication as it consists of a two-way dialogue between scientists and their audience. However, the main criticism against this approach is that it is limiting in that only a certain number of people can participate in public lectures, science centres and museums, science cafes and other

forms of face-to-face events at a given time. It is also considered to be limiting because people with a pre-existing interest in science are the ones who are most likely to attend these events (Bultitude, 2011).

For these reasons, the second approach: traditional journalism (i.e. newspapers, magazines, radio, and television) was believed to be a better way to communicate science as it could reach far larger audiences that extended beyond those who were able to physically participate in the public sphere. However, while the media could broadcast to mass audiences, this style of communication is one-sided. Information is prepared by professional journalists and then disseminated to audiences, which some scholars argue is problematic because its audiences are only able to receive a limited narrative from one viewpoint (du Plooy, 2005). Since the media act as the middlemen between scientists and society, the information being prepared might not always be accurate, especially if scientists are not consulted before publishing. This then allows for the rapid spread of misinformation that once consumed by the public, becomes very difficult to reverse as the scientists involved have no control over the information anymore. Bultitude (2011) suggests that this is why the relationship between scientists and journalists is tense. Whether intended to or not, the media are capable of affecting the way that consumers perceive scientific information (Retzbach & Maier, 2015), therein affecting the way that the public will formulate opinions about various topics (Lewandowsky, Ecker, Seifert, Schwarz and Cook, 2012). Scientists become frustrated with the media when their work is over-simplified or sensationalised for the sake of meeting sales objectives. Public health professor Tim Caulfield coined the term "scienceploitation" to describe this phenomenon (Groshek & Bronda, 2016:1).

On the other hand, some journalists argue that scientists are not always willing to cooperate with them, which makes it difficult for the journalist to report accurately in the first place (Yong, 2012). This is where the third approach, online interactions, becomes a blessing and a curse. If scientists are worried about their theories being misrepresented by the media and then shared with a mass audience, then the same fears are only amplified via the Internet. However, with this approach, there is room for conversations involving not only the media and its audience but also scientists if they choose to participate (Bultitude, 2011). Websites, blogs, podcasts and social media are all modern tools that can be used to communicate science. If combined with face-to-face events, online interactions can provide scientists with the potential to reach even more people.

It is true that scientists are being encouraged to join social media platforms because it is in their, as well as their funders' best interest, to compete for attention. However, beyond doing so to increase their own public visibility, there is evidence to suggest that scientists are also choosing to participate on social media for educational purposes. Collins, Shiffman, and Rock (2016) found that there are a number of scientists trying to improve science engagement and literacy rates by communicating directly with the public. This is a positive finding as many people are exposed to news and information via online sources, especially social media platforms (Pelger, 2017). While this may be convenient for content-hungry consumers it is problematic for science. Like a virus,

misinformation including fake news, so-called "alternative facts" and bad science, can spread rapidly via the Internet. There is a great need for scientists to mitigate the problem by making an effort to communicate directly with the public.

Scientists are using social media to communicate and exchange knowledge with other scientists, and there are many who read or write their own science blogs as well (Collins, *et al.,* 2016). Blogs are considered to play an important role in increasing public understanding of science, which is why many are joining the popular microblogging site Twitter. Although it is still quite a relatively new movement (most participants reported only having a Twitter account for two years even though the site has been operational since 2006) scientists claim to use it as a forum for disseminating research and a way to remain updated with what's going on in the science community.

When asked what would make them hesitant to join and use social media, respondents explained that they either had a lack of time or knowledge (Collins *et al.,* 2016). Like a living breathing organism, social media are constantly undergoing incremental changes. Although there are a variety of guides designed to help users navigate the changing social media realm, Bik and Goldstein (2013) argue that these do little to help researchers who are feeling overwhelmed by the very idea of joining the digital domain. Instead of relying on informal how-tos, scientists would prefer to rely on scientific, peer-reviewed journals for assistance. For this reason, Bik and Goldstein (2013) stress the importance of online science conversations that will help scientists feel familiar with the Internet and the vast number of resources it offers.

Ultimately, the goal is to make scientists feel less intimidated (Holmberg & Thelwall, 2014) and more empowered so that they can feel confident on social media. There is a demand for scientific institutions to offer formal training opportunities for graduate students and members of the faculty, who would like to learn how to use new technology in a constructive manner. Bik and Goldstein (2013) suggest that this training should address common misconceptions about social media and assist researchers to develop skills that will be suited for the often complicated online environment.

2.8) Visibility

According to Joubert and Guenther (2017), there are two types of visibility; 1) academic visibility, which is how well-known a scientist is within their own particular field, and 2) public visibility. The second category, public visibility, depends on how much media exposure a particular scientist is able to attract. This can be the result of their academic work and/or other involvement in debates and other activities that do not necessarily have to be science-related. However, it is not enough for scientists to participate in traditional modes of public communication such as presentations at schools and science fairs. Due to the competitive nature of the

Information Society, scientists have to seek out other ways to amplify their own voice via a combination of traditional (i.e. newspapers and television) and digital media platforms (Joubert & Guenther, 2017).

Movements like Open Science advocate making science as accessible as possible but despite the growing emphasis on the online interaction approach, there are certain factors that scientists must consider before jumping on board. For example, choosing to engage in online science communication, scientists must avoid publishing or reporting findings before their research has been peer-reviewed and published in legitimate scientific journals. Bultitude (2011) points out that reputable scientific journals will not publish work after it has broken the Ingelfinger Rule (Angell & Kassirer, 1991); which simply means research that has rushed to be published elsewhere, in the media or in other academic journals. Another factor to consider is how scientists will be perceived by other scientists if they decide to engage in communication, especially in an online environment. There are some scientists who have been criticised for being popular, giving rise to theories such as the Sagan Effect and Kardashian Index (Bultitude, 2011).

2.9) Factors that influence visibility

Joubert and Guenther (2017) suggest that the following four main factors influence a scientist's public visibility: seniority, organised culture, discipline, and controversy. Their research shows that journalists tend to prefer to interview scientists who are in senior positions because they are perceived to be leaders in their specific field. A senior scientist is also believed to be more likely to respond to requests for comment by the media as well as be able to handle any negative criticism from the public in a more mature manner. A key insight offered by Joubert and Guenther (2017:6) is the idea that scientists are supposed to "earn a scientific reputation before venturing out into the public arena." This is why 14 out of the 18 most visible scientists in their study were professors, as it is a title that gives them some form of credibility in the academic community.

However, while seniority and experience play a role in preparing a scientist for the responsibilities associated with public engagement, Cerrato, Daelli, Pertot and Puccioni, (2018) argue that the number of young scientists who feel it is their duty to engage with the public is high. These researchers also suggest that young scientists are also more likely to embrace the decentralised mode of communication; breaking away from the patriarchal, top-down style that has dominated academia for so many years, and caused a divide between those with knowledge (i.e. scientists) and those without access to it (the public) (Cerrato *et al.,* 2018).

The second factor, organised culture, refers to the "global research arena" (Joubert & Guenther, 2017:6) in which universities now have to compete with one another to capture the attention of funders and then justify why they should be given money to spend on research (Weißkopf & Witt, 2015). However, while organisational culture, policies, reward incentives, institutional expectations and the availability of communication support structures play a role in influencing public visibility, there are still institutional limitations (i.e. the Ingelfinger

Rule) that can be used as penalties against scientists who try to become publicly visible (Joubert & Guenther, 2017).

A scientist's field of research impacts his or her efforts to communicate with the public as some topics are considered to be of more interest than others (Joubert & Guenther, 2017). For example, topics that are relevant to everyday life, such as health and wellbeing, will resonate with audiences. Joubert and Guenther (2017) suggest that the jargon used by certain disciplines makes it difficult for the public to understand, even if they would like to. Similarly, the number of visible scientists per scientific field will also depend on the scientific opportunities that are available in each country. In a country like South Africa that has a "rich biodiversity and unique fossil heritage" (Joubert & Guenther, 2017:7) it is unsurprising that many of the publicly visible scientists mentioned in their study were from the biology and palaeontology fields. It is also not a surprise that the publicly visible health professionals mentioned specialise in areas including public health, HIV, and tuberculosis.

Controversy is the final, and perhaps most interesting factor, mentioned by Joubert and Guenther (2017:7), as it forms part of what they describe as a "feedback loop of media attention." By this they mean that controversy causes a scientist to become visible and then media attention adds to their visibility; intensifying their status in an unprecedented way. Both Berger and Noakes are examples of scientists who have been criticised by their peers and the public, which Joubert and Guenther (2017) suggest has most certainly boosted their public visibility. However, since Berger and Noakes are senior scientists with credible reputations for producing research worthy of international recognition, they have − in line with the first factor − been able to handle criticism much better than a younger, less experienced scientist would have.

2.10) Public understanding of science

So if we know more today than we ever have in the history of humankind, and we have access to unlimited information via ICTs, why then is there so much contention about what we − as a collective − know to be true? Kahan, Jenkins-Smith, and Braman (2010) answer this question with their theory called the Science Communication Paradox, and offer two potential hypotheses for why this is happening. Firstly, a popular explanation of the paradox is the Public Irrationality Thesis (PIT). This theory proposes that the general public does not have the same level of scientific literacy as scientists do and therefore cannot think in the same logical, deliberate manner. Instead, the general public will evaluate incoming information in an intuitive way, focusing on emotions and sensationalism rather than data and facts. Kahan *et al.* (2010) stress that PIT will eventually lead to there being more plausible accounts to describe complex phenomena that can actually be proven to be true.

The second hypothesis for the science communication paradox is called the Cultural Cognition Thesis (CCT) and occurs when certain groups of people assess evidence in relation to certain group identities. Kahan *et al.*

(2010) describe "motivated reasoning as the tendency for members of a particular social group to conform in their assessments in relation to an inaccurate goal. Similarly, when presented with facts that are typically associated with rival social groups, individuals will choose to support evidence that is in line with their own personal group identity.

Kahan *et al.* (2010) suggest that the only way to resolve the Science Communication Paradox is for scholars to focus on the science of science communication. Parallel to this, scientists are encouraged to communicate directly with the public instead of relying on the media to act as a translator (Musil, 2006), as the media often misinterpret important scientific findings. According to Ransohoff and Ransohoff (2001), the media relies on sensationalist tactics when covering serious scientific topics. This is done to attract readers in a market that is becoming increasingly cluttered and competitive. Ransohoff and Ransohoff (2001) argue that this type of distorted reporting is problematic because it can make people feel a sense of false hope or even fear, as they are not scientifically literate enough to evaluate the information being presented to them. This can lead to a media-fueled frenzy that is not based on logic or truth.

2.11) Scientists as celebrities

It is not unusual for scientists who have attracted attention to themselves to be both admired and envied. In 2014, genomicist Neil Hall conducted a study to measure the relationship between a scientist's number of Twitter followers in relation to their number of citations. Hall (2014) named his project the Kardashian Index (K-Index) after prominent reality TV star Kim Kardashian who has a reputation of being famous for the sake of being famous. Hall (2014) discovered that the scientific community has its own versions of Kim Kardashian; scientists that are well-known because of decent media exposure rather than because of the quality of their work. He suggests that some scientists are invited to attend conferences as keynote speakers because they have a large following on social media sites like Twitter, which will be great for publicity reasons.

In reaction to the Berger and Noakes controversies, South African science journalists Sarah Wild and Alex Eliseev, both shared their opinions on how each controversy affected the public sphere (Joubert & Guenther, 2017). According to Wild, Berger and Noakes are examples of "rock star scientists" that are guilty of oversimplifying their work and relying on anecdotes that are emotional. She suggested that their style of populist communication is a danger to how the public perceives and trusts science if of course, they should be proven wrong. In contrast, Eliseev argued that if scientists want to make their work more accessible then they have no choice but no simplify certain aspects of it. He also pointed out that there will always be debate about fossils and diets as both areas of interest impact the way that humans make sense of our collective past as well as our collective health. Eliseev defended Berger by describing him as a rare example of a scientist that has the ability to make science seem exciting and saw no issue with how Berger uses the media to help secure funding for his research because he is educating the public at the same time (Joubert & Guenther, 2017).

However, regardless of the circumstances that cause a scientist to become publicly visible, Krauss (2015) stresses that this does not have to take away any opportunities that popular scientists with an audience have to promote science and encourage the public to take an interest in it. If scientists use their presence responsibly, then they will be able to combat pseudoscience, motivate the youth to study science, as well as help guide public policy discussions so that they are supported by evidence-based science (Krauss, 2015). By using the word "responsibly", Krauss (2015) also means that scientists should be wary of commenting on topics that they are not qualified experts in. For example, upon winning the Nobel Prize, Feynman was approached by many different people − army general in particular − and asked to advise them on a variety of issues. After sharing his thoughts freely, Feynman realised that he was speaking about issues that he actually did not know much about, which caused him to rethink his public communication strategy. Of course, not all scientists can or should be expected to reach out (Krauss, 2015). Some scientists will be better than others at communicating with the public; either because they have an enchanting personality, like Einstein, or because they have managed to capture more than the public's attention but also its imagination as well (Krauss, 2015).

Chapter Three: Research Methodology

In this chapter, the research design and mixed methodology used to collect and analyse the data from Twitter, as well as the interviews with Noakes and Berger, is outlined and explained.

3.1) Research Design: Mixed Methodology

It is not uncommon for social scientists to choose a mixed method research design, even though their research approach is primarily quantitative as it deals with subjective human experiences, interpretations and meanings. Described as the "third paradigm" by Johnson and Onwuegbuzie (2004:15), mixing methods simply means that a combination of qualitative and quantitative techniques will be used to collect and interpret data that is relevant to the research problem (Cameron, 2009).

3.2) Sequential Explanatory Design

There are three ways to approach mixed methodology; these being concurrent, sequential and conversion (Tashakkori & Teddlie, 2003). For this study, a sequential research design with an explanatory angle, wherein the quantitative phase is followed by the qualitative phase, is suitable as more than one type of quantitative or qualitative method can be used to gather data. However, the findings made during the qualitative phase will be used to contextualise and give meaning to the quantitative data found during phase one, which is why this study is predominantly qualitative in nature (Bowen, Rose & Pilkington, 2017). The qualitative data is imperative as it will allow for the data to be interpreted in a way that will lead to the generation of new knowledge (Strange, 2006), which will ideally be of use to other science communicators.

3.3) Sample

There are two main types of sampling: probability and non-probability sampling (Latham, 2007). Since the research aims and objectives of this study are very specific, a non-probability, non-random sampling method known as purposive sampling is the appropriate choice. Purposive sampling is an effective and convenient method, especially when the researcher has limited time and financial resources available (Latham, 2007).

3.4) Phase One: Quantitative Data Collection

Due to the fact that both Berger and Noakes have a combined total of 57 877 tweets from the time period this study demarcated, it would be incredibly time-consuming to try to demarcate relevant tweets without some technological assistance. Firstly, an "Advanced Search" option is available to all registered Twitter users (Help centre > search and trends > how to use advanced search, 2018). To conduct an advanced search, users need to:

1) Enter their search into the search bar on twitter.com.
2) At the top of the results page, click More options and then click Advanced search.
3) Fill in the appropriate fields to refine the search results (see below for some helpful tips).
4) Click Search to see results.

Thereafter, the advanced search can be refined further if the user chooses to use any combination of the following fields (Help centre > search and trends > how to use advanced search, 2018):

- Words
- People
- Places
- Dates

Twitter.com advises users to try combine fields when doing an advanced search, in order to maximise their chances of finding exactly what they are looking for (Help centre > search and trends > how to use advanced search, 2018).

Secondly, another quantitative online tool that can be used to gather specific tweets is called TAGS v6.1.7. Developed by Martin Hawksey, TAGS v6.1.7 is a free Twitter spreadsheet that, when combined with Google's cloud-based Google Drive and Google Sheet software, allows users to interact with Twitter's Application Program Interface (API) (Van Rooyen, 2016). This software will be used to collect the more recent tweets made by Berger and Noakes, as Van Rooyen (2016) found that an analysis of more than 3 000 tweets (the TAGS v6.1.7 limit) will require a high-powered PC. Without access to one, there is a risk that this researcher's own equipment could crash, resulting in the loss of data that has already been gathered. However, since this software is being used in conjunction with the Advanced Search feature available on Twitter, the 3 000 tweet limitation is not an issue.

3.5) Phase Two: Qualitative Data Collection

Parallel to collecting 100 tweets from each scientist, a standardised open-ended interview had to be designed in a way that would allow the researcher to ask both Berger and Noakes identical questions even though one interview would be conducted in person (Noakes) and the other telephonically (Berger). The standardised open-ended interview style was selected as questions could be worded so that responses are flexible (Turner, 2010). According to Creswell (2007), the open-ended nature of this type of interview structure allows the participants to contribute as much detailed information as they would like to. It also gives the researcher the opportunity to ask follow-up questions that might not have originally been planned. However, although standardised open-ended interviews are a popular choice, there can be some difficulty when it comes to coding the data (Creswell, 2007). This is because participants are free to share as much detail as possible, which in turn makes it challenging for researchers to extract themes and codes from the interview transcripts. However, while it might involve a cumbersome coding process, this type of interview design also reduces researcher biases, as participants are given the opportunity to share their own narratives (Turner, 2010).

3.6) Phase Three: Content Analysis

A qualitative content analysis is a well-established research methodology and technique that can be used to make "valid and reliable inferences from the data to their context" (Kim & Kuljis, 2010:370), in order to enhance understanding about a specific phenomenon (Schreier, 2012). Advantages of this technique include the fact that it is 1) unobtrusive, 2) unstructured so the researcher can be flexible, 3) context-sensitive and can be applied to a large quantity of data and 4) it is a means to directly examine a specific artifact (i.e. a text or image) (Kim & Kuljis, 2010). Another benefit of qualitative content analysis is that it is an economical, cost-effective technique − especially if the data being collected and then analysed was gathered from an online source. However, it is important to note that content analyses based on data collected from The Web, can pose a challenge to researchers (Kim & Kuljis, 2010). Researchers must be aware of the complexities surrounding features such as mixed multiple media, interactivity, decentralised hyperlink structures (Kim & Kuljis, 2010), as well as the brevity and fluidity of online communication; particularly tweets, which have meaning that is embedded within a broader context (Goodman & Light, 2016). For this reason, the interviews conducted with Berger and Noakes will play a vital role in the analysis stage presented in chapter four.

3.7) Problem Statement

The aim of this thesis is to examine how South Africa's two most visible scientists, Lee Berger and Tim Noakes, cope with controversy by using Twitter to directly communicate with the public.

3.8) Research Questions

- What kind of language and tone do Berger and Noakes use when communicating via Twitter?
- How do Berger and Noakes connect and communicate with their audiences, including critics?
- Is there evidence that one or both of the studied scientists' history with controversy have influenced their style of communication on Twitter?

One hundred tweets published by Berger, followed by one hundred tweets published by Noakes shall, henceforth, be documented and then analysed in relation to the data collected from the standardised open-ended interviews conducted with each scientist.

Chapter Four: Data Collection and Analysis

Chapter four is dedicated to the presentation and content analysis of one hundred tweets collected from Berger's Twitter profile and one hundred tweets collected from Noakes' Twitter profile.

4.1) Lee Berger

Joined Twitter: April 2010

Keyword search: Homo naledi, controversy

Date search: April 2010 − April 2018

Number of Tweets in total: 7 858

Number of Tweets that will be analysed: 100

@LeeRberger will be placed before each tweet that was made by Berger himself, as this is his official username on Twitter. Also, direct quotes placed in the analysis sections are quotes made by Berger during the telephonic interview conducted on 6/06/2018. Similarly, the term "Quote Tweet" will appear when Berger has taken another user's tweet, shared it on his profile but added his own caption above it. Both the original tweet as well as Berger's captions will be provided for contextual purposes.

Tweets have been presented here as they were on Twitter; spelling errors/typos included. The analyses are based on observations made by examining the tweets (content analysis) and insights gained from interviewing Berger telephonically. However, before we begin, this is Berger's (2018) statement regarding why and how he chooses to use Twitter:

"I was a latecomer to the platform as I originally started using Facebook first. It took me a while to understand the potential power of Twitter and its ability to rapidly transmit short form ideas, highlight new discoveries, and influence the direction in which people will pursue knowledge. Twitter as a medium is powerful as it allows me to reach people. It is a root network, which means it doesn't matter how many followers I have; rather who follows me and then who these people then transmit to. There are of course advantages and disadvantages. I think it's important to keep your personal life off social media. I was already mature by the time I joined Twitter. In 1998 I started my first blog on paleoanthropology called Outpost. It failed miserably because the Internet wasn't large enough at the time. That's why by the time Twitter became popular I was ready for it. I entered with a purpose" (Berger, 2018).

Henceforth, the presentation and analysis of 100 tweets published by Berger:

4.1.1) Tweets 1-7 and analysis

11 Sept 2015

1) @LeeRberger: looking forward to being on 94.7 with @WackheadSimpson this morning to talk about #almosthuman #naledifossils #homonaledi

2) @LeeRberger: #naledifossils #homonaledi #almosthuman if only we had got there earlier....https://www.theonion.com/tearful-anthropologists-discover-dead-ancestor-of-human-1819578204

3) @LeeRberger: The cover of the @NewYorktimes_ON is whats happening! #naledifossils #homonaledi #almosthuman #newyorktimes

4) @LeeRberger: and of course the cover of @NatGeoMag #naledifossils #homonaledi #almosthuman October edition

5) @LeeRberger: #naledifossils #almosthuman #homonaledi on display @MaropengSA go see it Sept 11 to Oct 11

6) @LeeRberger: The women explorers behind the discovery of #naledifossils #homonaledi #almosthuman https://video.nationalgeographic.com/video/proof/150910-proof-naledi-female-cavers-short

7) @LeeRberger: Remember you can download the articles on #homonaledi #naledifossils for free @elife https://elifesciences.org/articles/09560

Analysis:

1-7) Berger tweeted several times on this day; all tweets related to giving exposure to *Homo naledi* in some way as he points out the commercial media platforms that will be interviewing/have interviewed him. He also links to an article about the women in his team. He is pro inclusivity. The free articles that can be downloaded indicate he is transparent as well. Berger uses more than one hashtag to increase visibility of each tweet.

4.1.2) Tweets 8-13 and analysis

12 Sept 2015

8) @LeeRberger: Worth highlighting on a busy day! Our "underground astronauts" https://www.washingtonpost.com/news/speaking-of-science/wp/2015/09/10/meet-the-six-female-underground-astronauts-who-recovered-our-newest-relative/?postshare=7701442017583143&noredirect=on

9) @LeeRberger: You can download the #homonaledi papers FREE from @elife http://elifesciences.org/content/4/e09560 … Also gives you links to morphosource for free 3D prints

10) @LeeRberger: Meet #homonaledi and the #dinaledifossils http://ewn.co.za/Features/Naledi #almosthuman

11) @LeeRberger: .@maropeng looking forward to people twting pics of themselves with #naledifossils like @surgiclprincss #almosthuman #homonaledi

12) @LeeRberger: Neat video leading up to the announcement of #naledifossils and #homonaledi

13) @LeeRberger: Take an incredible #3D journey through the #Risingstar cave to the chute #naledifossils #homonaledi https://www.youtube.com/watch?v=vI-JF28T44U …

Analysis:

8-13) By "meet" *Homo naledi*, Berger implies that he wants to share his discovery in a friendly and accessible manner. He also encourages engagement by asking users to tweet a picture of themselves posing with *Homo naledi* fossils on display. Berger is also a fan of using video and 3D technology to help him communicate in a holistic and interactive way.

4.1.3) Tweets 14-18 and analysis

13 Sept 2015

14) @LeeRberger: Coming up tonight on @carteblanchetv with @DerekWatts the #naledifossils featuring #homonaledi http://carteblanche.dstv.com/player/923464 #almosthuman

15) @LeeRberger: .@nature discusses #openacess and the #naledifossils and #homonaledi and the #Risingstarexpedition http://www.nature.com/news/crowdsourcing-digs-up-an-early-human-species-1.18305?WT.mc_id=TWT_NatureNews … #almosthuman

16) @LeeRberger: Almost 124000 page views and almost 14000 downloads of the FREE open access paper on the #naledifossils http://elifesciences.org/content/4/e09560 … #homonaledi

17) @LeeRberger: Happy #homonaledi and the #naledifossils discovery day - this day two years ago Rick Hunter and Steve Tucker descended into the chamber

18) @LeeRberger: "Best question of the day. If you took one of Homo Naledi's teeth and put it under your pillow, how much would the tooth fairy give you?

Analysis:

14-18) Berger regularly updates his followers so that they know where they can find information about what his mission is about. He occasionally slips in some humorous tweets as he tries to be relatable as a "normal" person as well as a scientist.

4.1.4) Tweet 19 and analysis

14 Sept 2015

19) @LeeRberger: Remember you can download the @elife papers #homonaledi #naledifossils for free at http://elifesciences.org/content/4/e09560/article-metrics …

Analysis:

Berger reminds followers and anyone who searches for the hashtags associated with this tweet, that they can access information for free.

4.1.5) Tweets 20-21 and analysis

15 Sept 2015

20) @LeeRberger: Almost 160000 page views & 16000 downloads of our article in @eLife. Very proud of #openaccess science #homonaledi http://elifesciences.org/content/4/e09560/article-metrics …

21) @LeeRberger: For those asking download both papers and get most if not all your questions answered about #homonaledi @elife http://elifesciences.org/lookup/doi/10.7554/eLife.09560.002 …

Analysis:

20-21) Berger is a firm believer in decentralised communication. "Prior to social media, high profile scientists (including myself) were very difficult to reach. There was strict protocol in place and access was limited to phone calls or letters that wouldn't always reach the scientist directly. Today, things are more transparent. It is much easier to get hold of me. People now have direct access to me via Twitter" (Berger, 2018).

4.1.6) Tweets 22-23 and analysis

19 Sept 2015

22) @LeeRberger: Clarifying for commentators who dont bother reading papers before speaking to media why #homonaledi is not erectus http://johnhawks.net/weblog/fossils/naledi/homo-naledi-homo-erectus-2015.html …

23) @LeeRberger: reporters quoting people who have not bothered to read the papers or look at the fossils of #homonaledi please read: http://johnhawks.net/weblog/fossils/naledi/homo-naledi-homo-erectus-2015.html

Analysis:

22) Berger's tone is frustrated because he has to deal with commentators who do not read his findings before speaking to the media.

23) Berger highlights how the media will quote so-called experts that are not informed or qualified enough to comment in the first place.

4.1.7) Tweets 24-26 and analysis

20 Sept 2015

24) @LeeRberger: Some brief replies to some of the critics of #homonaledi: https://www.iol.co.za/saturday-star/professor-rejects-dissing-of-naledi-find-1918477#.Vf5JLXnothg

25) @LeeRberger: A must read by @johnhawks for those doubting the species #homonaledi http://johnhawks.net/weblog/fossils/naledi/homo-naledi-homo-erectus-2015.html … published in @elife

26) @LeeRberger: #sciencewriters should all read @johnhawks measured reply to critics of #homonaledi before writing their next story

Analysis:

24) Berger takes the time to directly respond to critics of his theory.

25) Berger links followers to other sources that support his theory.

26) Berger is frustrated that science communicators do not take the time to find reputable sources to substantiate their arguments.

4.1.8) Tweet 27 and analysis

21 Sept 2015

27) @LeeRberger: How we kept the context of finds in the #dinaledi chamber while recovering #homonaledi and the #naledifossils https://www.facebook.com/profleeberger/posts/10153332938483323 …

Analysis:

Berger believes in being transparent. He wants to share as much detail about the context of and surrounding his work as possible.

4.1.9) Tweet 28 and analysis

21 Oct 2015

28) @LeeRberger: The case for #HomoNaledi deliberate body disposal examined

Analysis:

"I use Twitter as an extension of what I would post on Facebook in order to maximise my audience reach. An advantage of using social media, especially Twitter, is that it lowers the argumentative nature of scientists and forces them to think before responding/put their thoughts in writing" (Berger, 2018).

4.1.10) Tweet 29 and analysis

25 Oct 2015

29) @LeeRberger: My thoughts on some comments on our excavation methods and the selection of the primary excavators #Homonaledi https://www.facebook.com/profleeberger/posts/10153388742973323 …

Analysis:

Berger links users to a Facebook post where he defends his research methodology in more detail as Facebook does not limit the number of characters he can post per tweet. "The limited characters is tough − as you sometimes have to compromise on spelling to fit an entire idea into a tweet. It is a challenge to protect your reputation because one spelling mistake can invite trolls to criticise you" (Berger, 2018).

4.1.11) Tweet 30 and analysis

29 Oct 2015

30) @LeeRberger: Must read by @johnhawks on anonymous sexist comments related to the search for #Homonaledi

Analysis:

Berger feels very strongly against sexism and reminds users that he is in favour of inclusive, collaborative science.

4.1.12) Tweet 31 and analysis

10 Dec 2015

31) @LeeRberger: Useful commentary on the criticisms of the #Homonaledi papers http://www.sajs.co.za/sites/default/files/publications/pdf/SAJS%20111_11-12_Randolph-Qiunney_Commentary.pdf …

Analysis:

Berger links users to an article published by the SAJS (South African Journal of Science), which is a reputable source of information.

4.1.13) Tweet 32 and analysis

11 Dec 2015

32) @LeeRberger: A gift to the field for the holiday season the composite skull of #Homonaledi ready for 3D printing free to download http://morphosource.org/media/morphosource/images/8/1/33310_ms_media_files_media_8165_preview190.jpg …

Analysis:

Berger makes use of all kinds of technology to give users a holistic and engaging experience. He tries to make science fun.

4.1.14) Tweet 33 and analysis

16 Dec 2015

33) @LeeRberger: Free download of the #Homonaledi reconstructed skull for teaching and museums http://morphosource.org/index.php/Detail/SpecimenDetail/Show/specimen_id/2422 …

Analysis:

Another free offering for users who are interested in learning more about fossils and *Homo naledi* in particular- which is his area of expertise.

4.1.15) Tweet 34 and analysis

1 Jan 2016

34) @LeeRberger: More than 265,000 views and more than 27,000 downloads of the #Homonaledi paper since publication in September

Analysis:

Berger is transparent about the number of views he gets and how visible his work is. His popularity is not a secret nor does he try to cover the fact.

4.1.16) Tweet 35 and analysis

21 Feb 2016

35) @LeeRberger: .@sciam and @katewong cover #Homonaledi https://www.scientificamerican.com/article/controversy-and-excitement-swirl-around-new-human-species/

Analysis:

Berger links users to other articles published by credible sources such as *Scientific American.*

4.1.17) Tweet 36 and analysis

21 April 2016

36) @LeeRberger: #TIME100 recognizes the contribution of all colleagues involved in #sediba #Homonaledi and #openaccess. Honoured to work with all of you!

Analysis:

Berger refers to being acknowledged by *Time* magazine and thanks his colleagues. He does not view science as something done in isolation but rather as a collaborative effort that requires many different skills and perspectives.

4.1.18) Tweet 37 and analysis

17 May 2016

37) @LeeRberger: Our thoughts on dating #Homonaledi not behind a paywall with @johnhawks http://www.tandfonline.com.sci-hub.bz/doi/abs/10.1080/0035919X.2016.1178186?journalCode=ttrs20& …

Analysis:

Berger's tone here is a bit cheeky as he reminds users that they can access his information for free, in comparison to other scientific research, which is exclusive and must be paid for.

4.1.19) Tweets 38-39 and analysis

12 May 2017

38) @LeeRberger: https://fossilhistory.wordpress.com/2017/05/11/3-reasons-homo-naledi-is-headline-worthy/

39) @LeeRberger: 3 Reasons Homo naledi is Headline Worthy (that have nothing to do with controversy) https://fossilhistory.wordpress.com/2017/05/11/3-reasons-homo-naledi-is-headline-worthy/ … via @FossilHistory

Analysis:

Berger defends his research and shares three key reasons why the public should care about his discovery, all of which have nothing to do with controversy. He remains calm and continues to communicate despite being accused of pseudoscience.

4.1.20) Tweet 40 and analysis

27 June 2017

40) @LeeRberger: Thinking about criticism that we rushed the publications of #Homonaledi and #sediba thought of this by @johnhawks

Analysis:

Berger faces critics with a calm tone. "Sure I have trolls. They can become obsessive and time-consuming to deal with so I handle them in a variety of ways. I first try to examine who they are as it is difficult for anyone to make themselves truly "invisible" online. Then I try to understand their point of view, unless it is a Bot (i.e. web robot) which offers no real value. In that case I will block the user. It's rare though. If the comments are constructive then I will choose to engage with the person. Also, I have loyal followers who will interact on my behalf, so I often don't even have to deal with the trolls myself" (Berger, 2018).

4.1.21) Tweet 41 and analysis

4 Sept 2017

41) @LeeRberger: And we are live from the #Lesedi chamber! With Becca & Marina #Homonaledi

Analysis:

Berger announces that users can follow a live broadcast of his team as they work as he wants his audience to feel as included as possible.

4.1.22) Tweet 42 and analysis

25 Feb 2018

42) @LeeRberger: I am honoured to announce I have accepted the Presidency of National South African Spelaeological Association. Amatuer (sic) caving was the origins of the discovery of Homo naledi - We must cave with a purpose. Discover new places and new things.

Analysis:

Berger does not shy away from sharing his achievements with potentially millions of users. His tone is proud yet humble, as he reminds users of the importance of scientific discovery with a purpose (of doing all things with a purpose, actually).

4.1.23) Tweets 43-44 and analysis

28 Feb 2018

43) @LeeRberger: As we try to expand the follower base of our exploration into human origins it would help if my followers who have a #Sesotho or #Setswana base follow @Mathabela_Flip and that includes you @bonglez @Azania_ @Eusiabus @Derek_Hanekom its how we promote live science #Homonaledi

44) @LeeRberger: Tweeting science and exploration in African languages is critically important to sharing discoveries locally follow @Mathabela_Flip as we excavate and explore #Risingstar cave and #Homonaledi @Wits_News @NRF_News @dstgovza @NRF_SAASTA @CoE_Palaeo @UCamArchaeology @PerotMuseum

Analysis:

Berger is concerned with making his research as inclusive as possible, which is why he tweets about language and encourages his followers who do not speak English as a first language to follow his colleagues that can assist with translation.

4.1.24) Tweet 45 and analysis

8 March 2018

45) @LeeRberger: #Womeninscience doing there thing on #WomensDay at #Risingstar #Homonaledi this is what female scientists actually look like!

Analysis:

Berger believes in equality and therefore tweets about the female scientists he works with.

4.1.25) Tweet 46-48 and analysis

14 March 2018

46) @LeeRberger: .@Mathabela_Flip with a live feed on #Twitter as the skeleton comes up! Follow and watch as we see the block halfway in one of the most difficult parts@ #Homonaledi #RisingStar #Wifiinthecave

47) @LeeRberger: If you want to watch the packaged skeleton mid-chute follow @Mathabela_Flip and see how our explorers move through this incredibly tight space Oh and the skeleton is up and out of the chute! It will be coming down the Dragons Back shortly then through supermans crawl #Homonaledi

48) @LeeRberger: What a day at #Risingstar if you want to see the teamwork and excellent skills of our exploration team go to @Mathabela_Flip page and witness the archived videos of the #Homonaledi skeleton on its journey up the chute The team makes science and #Scicomm possible

Analysis:

47-48) Another live feed in order to allow the audience to engage with subject matter.

4.1.26) Tweet 49 and analysis

21 March 2018

49) @LeeRberger: I have a question, do you think the high level of chipping on Homo naledi teeth is due to the brittleness or strength of the enamel, Making it more prone to chipping?

Analysis:

Berger is not afraid to ask questions, he admits that he does not know everything.

4.1.27) Tweet 50 and analysis

30 March 2018

50) @LeeRberger: An outstanding @Medium article by @desilva_jerry on a mistrust of science in today's world - its a must read (oh and there is a special appearance in a picture of #Homonaledi in a local Museum near @dartmouth - which is fun!

Analysis:

Berger shares an article concerning mistrust of science. He wants users to engage with science and to not fear it.

4.1.28) Tweets 51-52 and analysis

18 April 2018

51) @LeeRberger: Today for the first time I got to stand in the #dinaledichamber where I could never venture physically but now can virtually. On May 3 you too can see the inside of the chamber @PerotMuseum and a few weeks after anyone in the world will be able to and it's awesome! #Homonaledi

52) @LeeRberger: After viewing the #Virtualreality of the #dinaledichamber I #Whatsapped my family noting it's pretty tight in there @Matty_Berger98 who has of course been in the #chamber sarcastically noted that he "didn't realize" #ChildrenwhogowhereIcannot

Analysis:

51) Berger points out that, thanks to technology, he is now able to access the Dinaledi Chamber (part of the Rising Star cave system), the space where *Homo naledi* fossils were discovered. The chamber was too narrow for Berger to physically enter himself, so a team of female scientists did the excavation in real life. Berger's son Matthew has been in the chamber before, when he was a child.

52) Berger shares an intimate insight/moment from his personal life; a joke made on another social media platform, WhatsApp, which allows his family to send messages to each other. From this insight we see that Berger enjoys making jokes and sharing the light-hearted moments of his life. He wants the public to see him as an accessible man.

4.1.29) Tweet 53 and analysis

22 April 2018

53) @LeeRberger: Oh... and @Marvel you have to give #sediba some superpowers and stuff. I promise we'll field test them @ #Malapa - I promise!

Analysis:

Berger tags Marvel in a tweet, asking them to give the fictional character called *Australopithecus sediba* (named after the species that Berger and his son discovered in 2008) superpowers. This tweet both reminds users of Berger's own work as well as the link between his work and popular culture.

4.1.30) Tweet 54 and analysis

27 April 2018

54) @LeeRberger: So how does one produce an article and graphics that ignore all the evidence? Homo naledi exists in this same time frame, all it lacks is a big enough brain to meet certain scientists and journalists preconceived ideas. https://www.newscientist.com/article/mg23831750-200-origin-of-our-species-why-humans-were-once-so-much-more-diverse/?utm_medium=EMP&utm_source=NSNS&utm_campaign=2018-0427-AprWK5-GLOBAL-Origins-Q2&utm_content=button&cmpid

Analysis:

Berger is frustrated that there are scientists and journalists who reject his theory without offering legitimate counterarguments.

4.1.31) Tweet 55 and analysis

11 May 2018

55) @LeeRberger: For all the scientists working on #Homonaledi and #sediba @eLife has a great way to publish timely updates and advances to your research - check it out https://crm.elifesciences.org/crm/sites/all/modules/civicrm/extern/url.php?u=41442&qid=11754827 …

Analysis:

Berger shares information that will assist other scientists with their own research.

4.1.32) Tweets 56-58 and analysis

14 May 2018

56) @LeeRberger: Letting everyone know - if you dont believe our results, you can download the actual 3D surface scans we used to interpret #Homonaledi's brain from @MorphoSource http://Morphosource.org

57) @LeeRberger: We provide all the evidence - free - download and print the endocast of #Homonaledi @MorphoSource

58) @LeeRberger: Something I am very proud of - when we publish fossils, the casts, scans, prints are always made available - you can check our results for yourself @MorphoSource http://www.pnas.org/content/early/2018/05/08/1720842115 … check out the brain of #Homonaledi just published in PNAS @PNASNews

Analysis:

56-58) Berger informs users of where they can find evidence to support his theory. He wants other scientists and the general public to be able to access the same data that he can.

4.1.33) Tweets 59-63 and analysis

15 May 2018

59) @LeeRberger: Getting Inside The Head Of Homo Naledi http://disq.us/t/32blvhk Dead things looks at .... well dead things... #Homonaledi

60) @LeeRberger: Could #Homonaledi talk? http://www.dailymail.co.uk/sciencetech/article-5727365/Mystery-hominid-species-pint-sized-brain-existed-alongside-humans.html

61) @LeeRberger: Where hominid brains are concerned, size doesn't matter: The human-like features of Homo nalei's brain surprise research team that examined fossil's brain imprints

62) @LeeRberger: Science News: Homo Naledi's Complex Brain, Thawing Permafrost, And The Evolution Of Hand Dominance

63) @LeeRberger: Ok I also think its the responsibility of scientists to make "minor appearances" and well,fill out "media appearances" come on, we can do better for #sediba - I mean @TheRealStanLee made a real hominid the origin of our species - do it justice! http://marvel.wikia.com/wiki/Australopithecus_sediba

Analysis:

59-62) Berger shares information concerning the size of *Homo naledi's* head and brain in order to get audiences to engage with the knowledge in an active way.

63) Berger is encouraging Marvel to let him make a "minor appearance" in the Marvel comic featuring the *Australopithecus sediba* character. This tweet is tongue-in-cheek and highlights Berger's interest in popular culture, as well as his desire to be part of it. Berger is challenging the stereotype that scientists can't enjoy the arts and culture.

4.1.34) Tweet 64 and analysis

17 May 2018

64) @LeeRberger: The Science of Storytelling https://blogs.plos.org/scicomm/2018/05/16/science-and-art-find-common-ground/#.WvyVS0VP7NE.twitter

Analysis:

Berger shares a link to an article linking science and storytelling; challenging the idea that there should be a divide between the natural and social sciences.

4.1.35) Tweet 65 and analysis

19 May 2018

65) @LeeRberger: It is perhaps my favourite job ad of all time - purely as it ends with - "Also, collect poop" check out @Benjamin_Finkel looking for assistants to work in the Kibale forest - just remember you must be able to "collect poop" besides the cool hanging out with Chimps etc.!

Analysis:

Berger makes a joke about a job advertisement stating that applicants interested in working with chimpanzees should also be willing to collect their fecal matter or "poop." Even though these tweets have nothing to do with Berger's own research it provides users with a humorous break from the norm/something unexpected.

4.1.36) Tweet 66 and analysis

25 May 2018

66) @LeeRberger: The most incredible tour of the new being human hall @PerotMuseum and @PerotMuseumCEHJ watch people interact with the exhibits and meet @BeccaPeixotto https://m.facebook.com/story.php?story_fbid=1629815470401591&id=212974792085673 … #Homonaledi #scicomm

Analysis:

Berger links users to information regarding a collaboration with an international institution.

4.1.37) Tweet 67 and analysis

28 May 2018

67) @LeeRberger: Some of the lowest numbers of scientists per million people in the world - that's us Africa, and it needs to change

Analysis:

Berger points out that Africa does not have enough scientists and implores his audience to take note so that something can be done to inspire the youth to take an interest in science.

4.1.38) Tweet 68 and analysis

2 June 2018

68) @LeeRberger: #openaccess science from the excellent @SAJS_Official - why age does, and doesn't matter in reconstructing phylogenies #Sediba as a case study https://www.sajs.co.za/article/view/4815 …

Analysis:

Berger provides a link to an open access journal article published by a reputable source.

4.1.39) Tweets 69-70 and analysis

6 June 2018

69) @LeeRberger: I talk frankly about those difficult times in the early 21st Century when some scientists proclaimed there was little else to be found it killed exploration for ancient hominins or at least funding for it outside of a few teams - those were tought times

70) @LeeRberger: I argue we are more "traditional" in our approach to science and publication of new hominid fossils than those that argue we publish "to fast" or in an unconventional way on @RNZ https://www.radionz.co.nz/national/programmes/ninetonoon/audio/2018639703/not-your-usual-fossil-hunter-lee-berger

Analysis:

Berger shares his honest thoughts about his scientific "journey" and the challenges that he has had to face.

4.1.40) Tweet 71 and analysis

15 July2018

71) @LeeRberger: The Lyda Hill Foundation via Nicole Small announces a significant gift of $1 million to ensure women scientists can change the world including family care! @NatGeo #Natgeofest [Attached picture of Nicole Small speaking].

Analysis:

Berger sheds light on initiatives designed to assist and empower female scientists.

4.1.41) Tweets 72-74 and analysis

16 July 2018

72) @LeeRberger: Follow @jessaddwater ultimate shark explore and soon to be comic book superhero-changing the world one fin in the water at a time!

22 June 2018

73) @LeeRberger: Watch this excellent @TEDX presentation by colleague Juliet Brophy - great work and an interesting story of her journey - take a listen! https://youtu.be/B1oGNPvLeOY via @YouTube

26 June 2018

74) @LeeRberger: Given that @Evo_Explorer was just named #Texas Biology Teacher of the Year, this Scientific American article on his coverage of #Homonaledi way back in 2015 is well worth a read he's an inspiration to teachers everywhere - its been a privelage – congrats

Analysis:

72-74) Berger tells his audience to follow another National Geographic explorer, a female, whom he believes is doing great things and deserves recognition. He also shares a link to a TED presentation done by a female colleague. Berger does not hesitate to give credit where credit is due, especially when women or other minority groups that have had a historical disadvantage are involved.

4.1.42) Tweet 75 and analysis

30 June 2018

Reply to tweet made by Paris Hilton:

"Tell me something I don't know...."

75) @LeeRberger: Too funny - @ParisHilton we met briefly at Universal Studios at a television critics association thing - you didn't mention you were an amatuer egyptiologist, nor, more importantly, were a fan of my favourite one @indyfromspace !

Analysis:

Berger replies to a tweet made by celebrity Paris Hilton, mentioning where and how he met her once in the past. He makes a joke by trying to link the popular culture figure to science, in an attempt to popularise science and prove that it is not something that has to be uncool or conservative.

4.1.43) Tweets 76-78 and analysis

2 July 2018

76) @LeeRberger: I was just reminded of this unsolved mystery I was involved with through an interesting series of communications and coincidences - the missing #Pekingman fossils - are they under a parking lot in China? https://blog.nationalgeographic.org/2012/03/22/are-the-lost-peking-man-fossils-buried-under-a-parking-lot-in-china/ …

77) @LeeRberger: The last moments of action and the death defying moments where the #Pekingman fossils might have been used as a machine gun mount would make a great movie! http://archive.sajs.co.za/index.php/SAJS/article/view/1122 … It certainly was an intriguing expedition..... and a great mystery still…

Reply to tweet:
"Hi. Sounds intriguing. But I'll need access to your harddrive to read that link. :-) Is the pdf posted anywhere online?"

78) @LeeRberger: lol here you go http://archive.sajs.co.za/index.php/SAJS/article/view/1122 …

Analysis:
76-77) When Berger uses language such as "mystery" and "death defying" he invites his audience to use their imagination in order to think about science as a means to solve questions about what it is we do not know yet. He wants users to get excited about science so that more people might take an interest in pursuing it as a career.
78) When his audience needs clarity or assistance, Berger is willing to interact and help.

4.1.44) Tweet 79 and analysis

3 July 2018
79) @LeeRberger: I like this summary of a very difficult conundrum - Darwin or Wallace https://fossilhistory.wordpress.com/2017/07/01/darwins-worst-nightmare-part-iii-conclusion-of-a-colossal-coincidence/

Analysis:
Berger shares a summary concerning a difficult topic so that more people can understand the information and participate.

4.1.45) Tweet 80 and analysis

4 July 2018
80) @LeeRberger: So how many paleo fans know that sediba is involved in the origins of X-men ? Perhaps the coolest thing ever for a fossil nerd challenge - beat having been involved in a fossil discovery that gives rise to X-men 3.2.1. Go!

Analysis:

Berger informs his audience of the link between the species he was part of discovering (*Australopithecus sediba*) and popular culture Marvel comic X-men. Berger wants people to see the ways in which science can be cool and fun.

4.1.46) Tweet 81 and analysis

5 July 2018

81) @LeeRberger: Very proud of my wife Jackie obtaining her Ph.D. today @WitsUniversity - a great achievement adding to her medical degree and her passion for diagnostic radiology and #breastcancer work in the clinical field - well done and we are all so proud of you! (I did get to hood her!) [Attached image of Berger's wife in her graduation gown].

Analysis:

Berger shares a personal story concerning his wife's academic achievements, making it clear that he is a family man as well as a scientist.

4.1.47) Tweet 82 and analysis

12 July 2018

82) @LeeRberger: Does anyone know of an earlier source published for the braided stream concept of human evolution than this 2012 illustration in the Skull in the Rock?

Analysis:

Berger uses Twitter to ask questions.

4.1.48) Tweets 83-84 and analysis

13 July 2018

Reply to tweet:

"Last night Netflix offered me @novapbs-"Inside Einstein's Mind" and "Dawn of Humanity" @LeeRberger"

83) @LeeRberger: How was Einstein's mind? :-)

Analysis:

83) Berger takes the time to respond to as many tweets directed at him as possible. Even tweets that have nothing to do with his own work but are attempts made by followers to reach out and communicate with him.

Reply to tweet that has subsequently been deleted since posted

84) @LeeRberger: That's not Orrorin tugenensis - thats Kenyanthropus platyops....

Analysis:

84) Berger will point out when inaccurate information concerning paleoanthropology has been shared on Twitter.

4.1.49) Tweet 85 and analysis

4 Aug 2018

85) @LeeRberger: Go @RedSox !

Analysis:

Berger is a fan of American baseball team The Red Sox. He shares elements of his personal life that are not too intimate but will help users understand him better as a person and not just as a scientist.

4.1.50) Tweet 86 and analysis

6 Aug 2018

Reply to tweet:

"I was always a choice... never a priority... I was always runner up never the winner... now I've become this heartless person... someone who's so cold on the inside... way to tired of this world…"

86) @LeeRberger: Don't say that Safiyyah - we value your contribution to #SouthAfrica and SA science as well as your position as a role model to girls and women in #STEM - you are a true ambassador for the #paleosciences on the continent- if you need support just say the word.

Analysis:

Berger comforts a colleague that is having self-esteem issues by reminding her that her work as a scientist does not go unnoticed. He also tells her that she is a role model to other women and should ask for help if she needs it. This shows an empathetic, caring side of Berger.

4.1.51) Tweet 87 and analysis

7 Aug 2018

87) @LeeRberger: In order to celebrate the 10th anniversary of the discovery of Australopithecus #sediba I am going to slip into the field, in a remote location, and see if I can work on another big discovery - shhhhh - August has been a good month for me in the past :-)

Analysis:

Berger reminds his audience that it has been ten years since the discovery of *Australopithecus sediba* and hints that he is going to embark on a new expedition in the near future. His language and tone is exciting; inviting users to follow him not only on Twitter but also on his journey to make new discoveries.

4.1.52) Tweet 88 and analysis

10 Aug 2018

88) @LeeRberger: In case you missed it - a great job opportunity for any interested in #scicomm teaching evolution and making a difference in people's understanding of human origins https://usr54.dayforcehcm.com/CandidatePortal/en-US/perotmuseum/Posting/View/341 … @PerotMuseumCEHJ @PerotMuseum @NatGeo @WitsUniversity #Homonaledi #sediba

Analysis:

Berger is an advocate of science communication and wants more people to join the field.

4.1.53) Tweets 89-90 and analysis

14 Aug 2018

89) @LeeRberger: I wish everyone who wants to be a scientist would listen to this interview. Its been ten years since a life changing event happened to me - but it wasn't a sprint, it was a marathon - I tell my story to @razibkhan and@@spwells

Reply to tweet:

Oh, no. You too, @SmithsonianMag?

"Laziness May Have Contributed to the Decline of Homo erectus"

90) @LeeRberger: "Laziness may have contributed to the decline of science journalism...."

Analysis:

89) Berger reminds his audience that science is not a "sprint" but rather a "marathon" which means it requires long term dedication and discipline to be a scientist.

90) Berger makes a comment about the current state of science journalism by comparing it to a quote extracted from an article published by the *Smithsonian Magazine* − a reputable source. He does not shy away from challenging well-established brands and institutions, if he believes they are responsible for producing weak and unscientific content.

4.1.54) Tweets 91-93 and analysis

15 Aug 2018

91) @LeeRberger: You can read all about the discovery of sediba on the tenth anniversary of its discovery in our children's book published by @NatGeoBooks #Skullinrock

92) @LeeRberger: Fantastic news about our @WitsUniversity @PerotMuseum @PerotMuseumCEHJ collaboration to bring more outreach and education to our understanding of the Human Journey - another great adventure and success for science education worldwide! https://eurekalert.org/pub_releases/2018-08/pmon-pmo081518.php

93) @LeeRberger: August has historically been a good month for me - exploration wise. Ten years ago on this day my son @Matty_Berger98 said "Dad I found a fossil" that worked out well. On saturday I am following another lead. I'll tell you more once we get the lay of the land. Wish me luck....

Analysis:

91-93) Berger uses Twitter to get people excited about initiatives and projects that he is involved in. He also continues to hint at his plans to work on a new discovery so that his audience does not lose interest along the way.

4.1.55) Tweet 94 and analysis

16 Aug 2018

Reply to tweet:

"The study of brain size is to comparative cognition what horoscopes are to psychology. Cheap, shallow, and devoid of scientific insight, but so under-constrained that anyone can find their little grain of truth in it."

94) @LeeRberger: Yet we continue in textbooks to produce images such as this - which are simply not evidence based. They are just an easy story to tell. Just take a look how Homo naledi messes this up. And there are other examples. [Attached is an image of a graph that Berger is complaining about].

Analysis:

Berger's tone is frustrated that school children are being exposed to information that is not evidence-based. Although he is frustrated, he does not use inappropriate language.

4.1.56) Tweet 95 and analysis

Reply to tweet:

"dear paleoanthropology colleagues, as i have now finally finished my syllabus for both Human Evolution & intro to Bio Anth please feel free to use the next five days to announce major discoveries thus requiring me to redo them. best, Marc"

95) @LeeRberger: Ok - hold my beer [attached with a picture he uploaded of a Castle Lite beer can in his hand].

Analysis:

Berger uses images to make jokes. He embraces the mixed media opportunities offered by the Twitter platform to add layers to his communication efforts.

4.1.57) Tweet 96 and analysis

17 Aug 2018

96) @LeeRberger: Wish @johnhawks and me good luck as we head into new, unexplored areas of remote Africa looking for.... something... We'll be out of range of cell reception but we are always under satellites! See you all in 12 days!

Analysis:

Berger announces that he will be out of range for 12 days but that he will be working on "something" of interest. His language is honest yet enticing at the same time so that his audience does not associate his absence from the online public sphere as a sign of his unwillingness to make an effort to include them in his work and/or the process.

4.1.58) Tweet 97 and analysis

23 Aug 2018

97) @LeeRberger: Join our team!
https://irec.wits.ac.za/OA_HTML/OA.jsp?page=/oracle/apps/irc/candidateSelfService/webui/VisVacDispPG&OAHP=IRC_EXT_SITE_VISITOR_APPL&OASF=IRC_VIS_VAC_DISPLAY&p_svid=77069&p_spid=3859317 …

Analysis:

Berger's use of the word "team" implies that they work together to achieve a common goal.

4.1.59) Tweets 98-99 and analysis

24 Aug 2018

98) @LeeRberger: In a wonderful area today with @johnhawks with wonderful potential for our team. The areas made for us. #exploration in the words of @Schwarzenegger we'll "be back"

99) @LeeRberger: Have you ever wanted to enter the #Dinaledi chamber and explore where #Homonaledi came from as if you were there like an #undergroundastronaut? You just might have the chance! @PerotMuseumCEHJ @PerotMuseum @WitsUniversity coming September.... #watchthisspace #openaccess

Analysis:

98) Berger refers to the popular catchphrase made by actor Arnold Schwarzenegger to add some humour and popular culture relevance to his work.

99) Berger invites users to continue monitoring his page for exciting information and opportunities.

4.1.60) Tweet 100 and analysis

25 Aug 2018

100) @LeeRberger: JJ I'm curious as to why you accept the Florisbad date as real (when you know it doesn't date the face but an isolated tooth) and you at the same time discount on new evidence the original Jebel irhoud date. Done by the same lab about the same time? What gives with that logic?

Analysis:

Berger calls out what he perceives to be examples of illogical thinking on Twitter.

4.2) Data Collection and Analysis: Tim Noakes

Joined Twitter: April 2012

Keyword search: HPCSA, controversy

Date search: April 2012 − August 2018

Number of Tweets in total: 50 000

Number of Tweets that will be analysed: 100

@ProfTimNoakes will be placed before each tweet that was made by Noakes himself, as this is his official username on Twitter. Also, direct quotes placed in the analysis sections are quotes made by Noakes during the face-to-face interview conducted on 31/05/2018. Similarly, the term "Quote Tweet" will appear when Noakes has taken another user's tweet, shared it on his profile but added his own caption above it. Both the original tweet as well as Noakes' captions will be provided for contextual purposes.

Tweets have been presented here as they were on Twitter; spelling errors/typos included. The analyses are based on observations made by examining the tweets (content analysis) and insights gained from interviewing Noakes in person. However, before we begin, this is Noakes' (2018) statement regarding why and how he chooses to use Twitter:

"Firstly, because I educate myself. Well, that's not the first thing but I probably pick up five or six scientific articles a day. I'm absolutely overwhelmed by the amount of information there is but I am also absolutely

current with what's interesting in this area of nutrition. In a way that you could never ever be on top of it like this. I follow a select group of experts and then they will tweet the stuff that is interesting to them. Of course it is biased because you go for the people that are involved in your own area, you have to understand that, but there's no better way. I send letters to cardiologists about journals that they haven't even read yet − that's the advantage you have.

"The day that it [the article] is published I have it and I usually have a copy of the article [printed out]. Obviously, there are still pay-walls so you can't get every article that you want but then you can always go to the university and get them. So there's no way, I mean I wrote the Lore of Nutrition and defended myself largely on material that I got out of Twitter because obviously, I have a basic knowledge but to keep current… there is no better way to stay current and I don't know how you can stay current without being on Twitter. That's a very important component.

"No, I don't use other social media platforms but only because I spend a lot of time on Twitter, so I just don't have the time to do the others. The second reason I use Twitter is to share the information I find and the third reason is to challenge conventional nutritional beliefs − so I will always have an edge and push stuff that's at the edge… ja… so that's all good. The downside is trivial, it's the "trolls" that you pick up and I've probably got eight or ten trolls over the period and I'm down to about two now. So they've all fallen by the wayside, which you have to ask why? They started because there was this goal to expose me as a quack with no, and I, I just completely lost it. It was clearly directed and, you know, the people who were directing it are clearly obvious.

"I run my own account, which is terribly important because it boils down to telling the truth and being transparent. First I go through all my tweets, which takes about 2,5 hours or so. Then I will download important articles and file them. They will be in the back of my mind for when I write books or articles. I'm retired so using Twitter gives me something to do. If I was a full-time academic I wouldn't have time to do it. I justify using Twitter because I am able to reach more people through the platform" (Noakes, 2018).

Henceforth, the collection and analysis of 100 tweets published by Noakes:

4.2.1) Tweets 1-2 and analysis

25 Oct 2012

1) @ProfTimNoakes: @AngeloZack What will HPCSA say now that 11 year LOOK Ahead study proves low fat diet cant prevent diabetic complications? Retract? Unlikely

2) @ProfTimNoakes: @gregorgeorge Certainly hope HPCSA will now be issuing warning about dangers of lo fat diet for diabetics following LOOK Ahead study results

Analysis:

1) Noakes asks user @AngeloZack to comment on the fact that there is evidence to suggest that a low fat diet cannot prevent people from developing diabetes-related complications. Noakes' tone is provocative and sarcastic because he does not believe that the HPCSA will do the right thing, which is to retract the charges laid against him.

2) Noakes says to user @gregorgeorge that he hopes the HPCSA will take action based on the findings of the study alluded to in the previous tweet.

4.2.2) Tweet 3 and analysis

26 Oct 2012

3) @ProfTimNoakes: @physiomarty Does HPCSA ever question whether their fab diet has anything to do with burgeoning rates of diabesity in SA? Too much to hope?

Analysis:

Noakes poses what he believes to be a rhetorical question to user @physiomarty. His tone is frustrated because he does not think that the HPCSA is doing what is in the best interest of the health of South African citizens.

4.2.3) Tweets 4-5 and analysis

27 Oct 2012

4) @ProfTimNoakes: @Helenbuhl HPCSA needs advice on scientific method. Cite 2 associational studies as if proof. Beginner's error. No scientific credibility.

5) @ProfTimNoakes: @Helenbuhl My father who followed HPCSA guidelines lost limbs/speech/life to diabetes. But my sister eats lo-carb diet for 50 yrs is well.

Analysis:

4) Noakes accuses the HPCSA of not understanding the scientific method; a criticism that he himself has associated with, as some argue that Noakes is practicing pseudoscience.

5) This tweet, to the same user, suggests that Noakes' father died because he followed the low-fat diet promoted by the HPCSA and that his sister is healthy because she follows the low-carb diet. This is an example of an anecdote. When asked about anecdotes, Noakes said "I can't wait 10 years to have the final answer. I must use all the evidence I have to try and help my patients so that they do not drop dead. I must act on incomplete evidence and back myself to work that out. The critics say I can't do anything

until I have the final answers but that's industry-driven because they direct the science that will direct industry" (Noakes, 2018).

4.2.4) Tweets 6-9 and analysis

27 March 2014

6) @ProfTimNoakes: @Dianivangraan3 Have been reported to HPCSA for advising breastfeeding moms to feed baby on LCHF. My view: Low carbs best for mom and baby

11 Feb 2015

7) @ProfTimNoakes: .@TaliaG28 My impression is that control of what is taught as nutrition at SA Universities lies outside University perhaps with HPCSA (cont)

Reply:

8) @ProfTimNoakes: .@taliag28 So whomever controls HPCSA determines what may and may not be taught. Insures all are taught the same regardless of institution

9) @ProfTimNoakes: @BattleBrewMCT I have to appear before HPCSA. "Charges" are really interesting - bad behavior on Twitter. Must be professional 1st for SA

Analysis:

Noakes is transparent about the accusations made against him. He creates a thread by stating (cont) which means "continue," to highlight that he has more to say in the tweets that will follow. This is a way to get around the character-limit, especially prior to the change from 140 to 280 characters. He uses quotation marks when referring to the charges laid by the HPCSA, as he does not believe them to be legitimate. His tone is that of contempt towards that HPCSA but he does not outrightly use any derogatory language; his disdain and frustration is implied rather by his tone than by his choice of words.

4.2.5) Tweet 10 and analysis

17 June 2015

10) @ProfTimNoakes retweeted a link to blog:

http://thenoakesfoundation.org/news/blog/profs-words-the-banting-for-babies-hearing

Analysis:

"I retweet plenty of stuff. Much more than I tweet. I want to share insights that are important. I must say one thing, what it has taught me is to get physiological principles down to 280-characters, which is amazing. It makes you think differently so I've posted some really good tweets which I didn't realise were

in my head until I saw someone say this that I then felt the need to respond. It makes you think in a new way" (Noakes, 2018).

4.2.6) Tweet 11 and analysis

1 Dec 2015

Quote Tweet:

"@ProfTimNoakes @LuaWilkinson @janvyjidak Anyone who thinks a normal pancreas will allow keto-acidosis doesn't understand insulin homeostasis"

11) @ProfTimNoakes: Clear from the @HPCSA_ trial that not everyone understands this basic feature of human biology

Analysis:

Noakes is annoyed that the original tweeter is accusing him of not understanding how the pancreas works in relation to insulin homeostasis − a topic that impacts blood sugar levels and therefore, diabetes. Noakes defends himself without relying on swear words or overly aggressive language. Instead, his tone implies his mood and feelings towards what is being said.

"I don't mind people disagreeing with me. I know more than these people though. I've spent the last 7 years reading about nutrition. I've probably read 400 books. I read 5 new article papers every day. I've dedicated this period because I had to try and save my career. So if they honestly knew as much as I did then that would be fine. Like some of the people I follow. I would immediately acknowledge their superior knowledge and refer people to them. Example − I'm not an expert on fasting so I refer them to my friend who is and that's how you do it. Not everyone can know everything about everything. I am an expert in type two diabetes and the management of type two diabetes and insulin-resistance. That's the area I'm interested in.

"Also, what interests me is that the trolls know nothing about science. They pretend that they are the expert in science when they aren't" (Noakes, 2018).

4.2.7) Tweet 12 and analysis

6 Dec 2015

12) @ProfTimNoakes: .@shamrockcharlie @Jo_deKoning @HPCSA_ @MarikaSboros Thanks Kelli. We're working hard to raise good from the ashes of ridiculousness

Analysis:

Noakes directly communicates with users who show support. He does not hide his negative feelings about the HPCSA trial.

4.2.8) Tweet 13 and analysis

9 Dec 2015

13) @ProfTimNoakes: .@lose_it_love_it Please come to February HPCSA Hearing. You'll hear whole truth. 400 slides. ~10 hours of evidence. Nor letter to CTimes

Analysis:

Truth is of major importance to Noakes. "I was raised by parents who were terribly honest, so I always try to be as honest as possible" (Noakes, 2018).

4.2.9) Tweet 14 and analysis

14 Dec 2015

14) @ProfTimNoakes: Thanks @sarahemilywild for another misinformed personal attack in Science Forum. Expect you to be present at HPCSA hearing in CT begin Feb 8

Analysis:

Noakes directly challenges the science journalist Sarah Wild, who was one of the journalists who criticised Noakes for being a "rockstar" scientist (Wild, 2015). He is confident that he will win the trial so he does not shy away from making it clear that he will not back down. When asked if Sarah Wild or any of his other notable critics asked to meet with him in person to interview him before criticising him he said: "No, they aren't interested in meeting with me because they have an agenda. Why should they attack me? What have I done wrong to them? I'm a deeply committed scientist. I'm an A1 rated scientist and they have tried to prove I'm a quack. By the way, the concept of me being a "rockstar" irritated me because journalists would call me that. Wild called Berger and myself "rockstars" and that we were damaging for science. Because we said things before they were known in science and therefore if the public found out that these things were wrong then they would lose faith in science. She had an agenda. Why call me a rockstar? I'm not a rockstar. I'm a scientist. An A-1 rated scientist. Rockstar is so demeaning and is an ad hominem argument (Noakes, 2018).

4.2.10) Tweet 15 and analysis

17 Dec 2015

15) @ProfTimNoakes: .@cda3108 @HELPdietSA @FForensics @AlastairMcA30 @MarikaSboros All to be revealed during 8-day @HPCSA_ CT hearing begin Feb 8th. All welcome

Analysis:

Noakes' tone can be interpreted as being quite confrontational; a mixture between confidence and perhaps even some arrogance.

4.2.11) Tweet 16 and analysis

22 Jan 2016

16) @ProfTimNoakes: .@wilmotjames So sad Mr James, so sad. Hope you'll attend HPCSA trial to enlighten yourself and help save SA. Recall I spoke to your caucus

Analysis:

Noakes often uses what can be perceived as a harsh or condescending tone but he maintains that he speaks the truth and is only blunt towards users who do not bother to ask him questions, or those – in this case, politician Wilmot James − who accuse him without evidence to support their arguments.

4.2.12) Tweet 17 and analysis

20 Feb 2016

Quote Tweet:

"The darkest places in hell are reserved for those who maintain their neutrality in times of moral crisis Dante Alighieri"

17) @ProfTimNoakes: Lovely quote from friend at @HPCSA_ hearing. God saves his toughest tasks for his strongest soldiers

Analysis:

Noakes compares himself to one of God's soldiers. He is confident that he will win the trial. These comparisons can be off-putting to users of a religious or politically correct nature. He is aware that his choice of words might be considered offensive to some but defends himself by reiterating how frustrated he was at the time he was writing these tweets.

4.2.13) Tweet 18 and analysis

25 April 2016

18) @ProfTimNoakes: If @DietitianClaire "wins" case, no SA doctor/dietitian ever again allowed to give general diet advice to public

Analysis:

"My error was to question one part of medicine because when you question one part then you start to see that the whole thing falls apart" (Noakes, 2018). Noakes is honest about where he goes wrong and why he believes he is being criticsed.

Claire Julsing-Strydom reply:
"@ProfTimNoakes another thing. You know this is a HPCSA case, not a you against me case. So let's stop with that misinformation"

4.2.14) Tweet 19 and analysis

26 April 2016
19) @ProfTimNoakes: .@DietitianClaire Documents served on me by HPCSA crystal clear. You, not @ADSA_RD, are complainant. Will release evidence when appropriate.

Analysis:
Noakes ends the he said/she said conversation between himself and Claire Julsing-Strydom by saying that he has evidence to support his innocence. He also claims that it is "ironic" that Julsing-Strydom was the one to report him because "she broke all the rules I was accused of breaking, herself" (Noakes, 2018). Noakes isn't scared of online conflict, even if it results in either him or his opponent blocking the other.

4.2.15) Tweet 20 and analysis

13 Oct 2016
Quote Tweet:
"Tim's Angels to speak on The Trial! To hear them, book now, quick! http://foodmed.net/2016/10/13/tims-angels-dinner-oct-26-lchf-noakes-banting/ … @TheNoakesF @ProfTimNoakes @HELPdietSA #LCHF"

20) @ProfTimNoakes: Please join us to celebrate (hopefully) final day of the @HPCSA_ @ADSA_RD "Hearing". Once in a lifetime to hear The Three Angels in Africa

Analysis:
"Tim's Angels" are his loyal supporters. He refers to the hearing in quotation marks because he does not believe there is a legitimate reason for it to be taking place.

4.2.16) Tweet 21 and analysis

28 Oct 2016
Quote Tweet:
"Dear Prof Tim. I wish you the very best innthe case. Personally i think the charges are bullshit. Thanks for being a pioneer"

21) @ProfTimNoakes: Thanks Nikk. Our team gave everything we possibly could at @HPCSA_ Trial. There was nothing more we could've done. Definition of perfection.

Analysis:

Noakes takes the time to respond directly to followers, especially those who do not try to "attack him" without being provoked (Noakes, 2018).

4.2.17) Tweet 22 and analysis

Quote Tweet:

"Confused by @HPCSA_ drama? Here's @TheNoakesF's statement. Let's send @ProfTimNoakes our support! #ImwithTim"

22) @ProfTimNoakes: Here's our statement on @HPCSA_ press release earlier today.

Analysis:

In order to remain transparent, Noakes updates users by sharing statements regarding the HPCSA trial.

4.2.18) Tweet 23 and analysis

30 Oct 2016

Quote Tweet:

"https://www.medicalbrief.co.za/archives/noakes-defender-says-statins-crime-humanity/"

23) @ProfTimNoakes: Thanks to @MedicalBriefZA for keeping medical colleagues informed about @HPCSA_ "Trial"

Analysis:

The word trial is in quotation marks because Noakes doesn't believe there is a legitimate reason for it to be happening. His tone probably shows contempt towards the HPCSA.

4.2.19) Tweet 24 and analysis

6 Nov 2016

24) @ProfTimNoakes: If you read that complete paragraph you'll understand what HPCSA trial is really all about. To destroy my scientific credibility for all time https://twitter.com/DrRobWeaver/status/795307987954991104 …

Analysis:

"Medicine has made people scared of the unknown. The only way that medicine and the pharmaceutical industry can survive is to have patients that don't get better. That's the key. If the pharmaceutical industry actually cured patients then it would collapse. The problem with what I'm promoting is that it does cure you. Of all these major conditions so you don't need drugs. So it's not even the way I'm saying it, it's what I'm saying. The point is I'm an A1-rated scientist with credibility for other reasons. I was quite iconic. People don't understand that" (Noakes, 2018). Noakes does not care if he is perceived as being arrogant for he has worked hard to achieve his credentials.

4.2.20) Tweet 25 and analysis

3 Dec 2016

25) @ProfTimNoakes: Apparently if I'm found guilty in @HPCSA_ "Trial" I might be liable for all costs http://bit.ly/2gSMTRR And if I "win"? @MisterPikester

Analysis:

Noakes' challenges the HPCSA by asking questions that are perhaps perceived as awkward and uncomfortable by some, especially since he had not won the trial at the time this tweet was made.

4.2.21) Tweet 26 and analysis

10 Jan 2017

Quote Tweet:

"you're a class act prof well done for thanking these people. Finally some ethical journalism!"

26) @ProfTimNoakes: Thanks @crusieboy Blessed to be supported by most phenomenal, caring, selfless people as result of @HPCSA_ trial. The very very best

Analysis:

Noakes acknowledges his support system and that he does not work in isolation. "If you look at my feed you'll see how much colour there is. You won't see my face plastered all over the place. If you go look at other people's tweets, you'll see only their faces. That's the difference. I embrace a sense of community. Develop a community. Go look at the trolls' profiles and you'll only see their own faces and own ideas. They never retweet someone else's study ever. Unless it will benefit them. I have no worry that you will find any contradictory data when you study my account" (Noakes, 2018).

4.2.22) Tweet 27 and analysis

6 April 2017

Quote Tweet:

"IMHO: @HPCSA_ and @ADSA_RD have never let research facts interfere with science fiction of this case against @ProfTimNoakes #LCHF"

27) @ProfTimNoakes: Let's not forget that @HPCSA_ has spent many, many millions of rands in attempt to prove that #LCHF science is wrong. Failed dismally.

Analysis:

Noakes tries to make his audience aware of what the HPCSA did to him in an attempt to "stop the same thing from happening to another scientist in the future" (Noakes, 2018).

4.2.23) Tweet 28 and analysis

22 April 2017

28) @ProfTimNoakes: Let's get facts straight. @dietitianclaire laid complaint without ever speaking to me. @ADSA_RD never ever spoke to me about this case

Analysis:

Noakes speaks openly and plainly about the facts as transparency and honesty is key − in his opinion − especially amidst online clutter and confusion.

4.2.24) Tweet 29 and analysis

23 April 2017

Quote Tweet:

"Another @ADSA_RD dietitian defames @ProfTimNoakes? Has closed her FB page. Wonder why? Will ADSA president take action? @sacrisis"

29) @ProfTimNoakes: Not everyone overjoyed with the HPCSA ruling it seems. #LaurenBartholomew on a roll.

Analysis:

Noakes is not afraid to call out his critics in a public way. He does this because he says that none have bothered to talk to him directly before going public with criticism.

4.2.25) Tweet 30 and analysis

27 April 2017

Quote Tweet:

"So Tim Noakes will be speaking at the Pan African Integrative Medicine (quackery) Congress in May in CT with homeopaths. What an honour!"

30) @ProfTimNoakes: Guess I had hoped that the ending of the @HPCSA_ trial would bring an end to this sort of journalistic drivel. Clearly too much to hope for

Analysis:

Noakes uses a sarcastic tone to cope with information associating him with quackery.

4.2.26) Tweet 31 and analysis

5 June 2017

Quote Tweet:

"Please join us for the launch of THE QUIET MAVERICK by @darylilbury with @ProfTimNoakes and @johnmaytham at @book_lounge on 22 June at 18:00"

31) @ProfTimNoakes: Carefully constructed book. Explains why social media poses real threat to future of medicine/dietetics; why HPCSA's case vs me is untenable

Analysis:

Noakes uses Twitter to advertise other products that are related to his cause. The platform also serves a promotional function for him.

4.2.27) Tweet 32 and analysis

9 June 2017

Quote Tweet:

"Eggs boost baby growth, study finds http://bit.ly/2sjMM7F"

32) @ProfTimNoakes: Research..showed eggs fed to babies from the age of six months increased growth and reduced stunting by 47%". Don't tell @ADSA_RD @HPCSA_"

Analysis:

When Noakes finds a link to evidence that contradicts what the HPCSA advises, he tags them in the tweet. This can be interpreted as a jab/condescending move. Noakes claims he does it because he was "dragged through the mud" by the HPCSA and almost had his scientific credibility compromised, so he feels the need to be vocal about the LCHF diet.

4.2.28) Tweet 33 and analysis

21 June 2017

Quote Tweet:

"And how much money is it that you make selling #LCHF diet books @ProfTimNoakes ?? Does this make you biased?"

33) @ProfTimNoakes: Thought you knew. I don't make a cent. Donate all to @TheNoakesF Ever considered how much @HPCSA_ @ADSA_RD @Dietitianclaire trial's cost me?

Analysis:

Noakes is transparent about his finances and does not shy away from the topic even though some consider it taboo. He makes it clear that he is not trying to make money but rather to help people live healthier lives. "I'm a fatalist, if it happens, it happens. [being targeted violently for his views] What we've done is irreversible. We've put the power back into the hands of the people. I would just be a martyr for the cause" (Noakes, 2018).

4.2.29) Tweet 34 and analysis

30 August 2017

Quote Tweet:

"People have been trying to help the world with this info for years! @ProfTimNoakes @garytaubes @VinnieTortorich"

34) @ProfTimNoakes: And some of us were prosecuted for saying exactly this - @ADSA_RD @HPCSA_ @zoeharcombe @bigfatsurprise @DrAseemMalhotra

Analysis:

"What I did on Twitter was completely within my bounds/guidelines as a medical professional because I answered a "we" question. It wasn't an "I" question. They accused me of bringing discredit to the dietetics profession and referred to it as "The Noakes Problem." Twitter wasn't to blame. The HPCSA wanted to achieve that Twitter could not be used to give out any information or advice on any medical topic by any professional registered with the council. If they had won, it would mean that there would be no more articles written by professionals, books, lectures, consultations on the phone or radio TV programmes" (Noakes, 2018). Noakes speaks in a factual, transparent manner.

4.2.30) Tweet 35 and analysis

2 Oct 2017

Quote Tweet:

"hey @ProfTimNoakes where is that book you said is coming out in September? #lchf saved my life I've lost a total of 39kg #banting #diet"

35) @ProfTimNoakes: Lore of Nutrition: Challenging conventional dietary beliefs. Written with @MarikaSboros.Truel facts about my @HPCSA_ trial.To printers today

Analysis:

Noakes uses Twitter to spread news about his own research. "I don't often tweet my own work − I only do when it's relevant. My focus is on the much bigger question of nutrition for health and examining the current dietary guidelines. People do need to know that I do "do" some science. But my focus extends beyond that" (Noakes, 2018).

4.2.31) Tweet 36 and analysis

20 Nov 2017

Quote Tweet:

"Dietary guideline to 'make starchy foods basis of all meal' doesn't help? On what earthly evidence did the academic who wrote it make that up? None that my research shows! @CarynZinn @ProfTimNoakes"

36) @ProfTimNoakes: This is a key reason why I was prepared to risk my scientific legacy by fighting the @ADSA_RD @HPCSA_ case against me. Stunting is minimized by "weaning" onto nutrient-dense low carbohydrate real foods. Much science shows this (as we showed in the "trial")

Analysis:

"My tone on Twitter is serious, scientifically-based and credible. It's edgy − I'm not scared to expose the weaknesses of my profession and of science. I want to share evidence to convert the world, to make them realise that we have a real problem that needs to be changed" (Noakes, 2018).

4.2.32) Tweet 37 and analysis

6 Dec 2017

Quote Tweet:

"@ProfTimNoakes no longer a medical practitioner? Just spotted this bit in your Twitter profile. A direct/indirect result of the UCT/HCPSA saga?"

37) @ProfTimNoakes: Just to make sure that everyone knows that everything on this Twitterfeed is information, not my medical advice. And if I respond to an individual (s)he does not become my patient. WE DO NOT HAVE A DOCTOR-PATIENT RELATIONSHIP. Is that clear @HPCSA_ @ADSA_RD?

Analysis:

Noakes pokes fun at the HPCSA by making it clear that he is not trying to give medical advice on Twitter, even though he won the trial.

4.2.33) Tweet 38 and analysis

2 Jan 2018

38) @ProfTimNoakes: Most delicious moments in my @HPCSA_ trial was when Mike van der Nest reminded @DietitianClaire that telling someone NOT to do something is also medical advice. So all those who tell their Twitter followers NOT to do LCHF are giving medical advice. And are all qualified to do so?

Analysis:

"With respect, no one has got my qualifications. I'm an A1 rated scientist and that means I am recognised as the world authority by the South Africans. I have medical training. I have a doctorate in science, which is the highest degree that university offers and I have an honorary PhD. I have a DSc, which very few in our country have, specialising in sports science and nutrition. So the people I was put up with in the trial just didn't have a clue. They were not in the same league. If you had to rank it, there is no one in South Africa with my expertise in the science of nutrition because dietetics isn't about the science of nutrition. It's home economics. However, there are obviously people overseas that are more knowledgeable about insulin resistance simply because they've been in the field for perhaps longer or they have an expertise in biochemistry that I don't have. Then I defer to them" (Noakes, 2018).

4.2.34) Tweet 39 and analysis

19 Jan 2018

39) @ProfTimNoakes: Interesting that I was charged with unprofessional conduct by @HPCSA_ and @ADSA_RD for providing "unconventional" dietary information to a breastfeeding mother. We showed advice to eat animal products is evidence-based. Zero evidence to support weaning onto plant-based diet.

Analysis:

Noakes does not hesitate to draw attention to what he perceives to be hypocrisy or unfairness. "I've become more confident. I now understand it better. I made all the errors before I started using Twitter, that's when I changed my dietary advice in 2010. About a year before I started Twitter" (Noakes, 2018).

4.2.35) Tweet 40 and analysis

27 Jan 2018

Quote Tweet:

"Science is a dangerous idea to those who believe in the current paradigm', says @integrativeDC. Isn't that the truth! Reason enough to follow him. New breed of #doctors who are not in thrall of industry and dangerous dogma! Like @ProfTimNoakes, @lowcarbGP and many others!"

40) @ProfTimNoakes: Prosecution in my @HPCSA_ @ADSA_RD did not feel it necessary to present any evidence why LCHF/Banting diet is "dangerous ". In spirit of postmodernism, they act as if we can dispense with facts; identity as "other" is all that's needed to prove guilt. Who needs any science?

Analysis:

"If anything is going to stop industry from making money then it will be stopped. The scientific method has been distorted by industry" (Noakes, 2018). Noakes is transparent about his theories and opinions.

4.2.36) Tweet 41 and analysis

30 Jan 2018

41) @ProfTimNoakes: Anything that takes away scientist's freedom of speech has to be anti-science. In the final analysis my @HPCSA_ @ADSA_RD trial is all about freedom of scientific speech. I expressed my scientific opinion, which is my right in the constitutional democracy in which we live in SA.

Analysis:

Noakes wants to defend the integrity of science and uses Twitter as a vehicle to spread his thoughts and ideas with the general public.

4.2.37) Tweet 42 and analysis

16 Feb 2018

Quote Tweet:

"I pray he [Noakes] never leaves the country and benefit other countries. Look at people like Elon Musk, Mark Shuttleworth & many, many others who could have added so much value n benefit the SA GDP."

42) @ProfTimNoakes: Speaking this last week with doctors from Germany and the US; both said that @HPCSA_ @ADSA_RD trial against me could not have happened in their countries. Thus the paradox: Only because we live in South Africa were we able to make this stand for Truth. We're not going anywhere.

Analysis:

Noakes makes it clear that the pursuit of truth is his top priority. "I build trust in real life by working with the patients and on social media by telling the truth. It's that simple. It's a ground-up movement that will win in the end because we are the ones helping the patients. The advice we are giving them works and it doesn't matter what the experts say. That's why I focus on telling the truth and exposing the untruths and I try to do both of them. The people who follow me and trust me will say this man is as straight as a

die. If it changes, I change. If you attend my lectures you will hear me say I made a mistake and I'm sorry" (Noakes, 2018).

4.2.38) Tweet 43 and analysis

16 Feb 2018

43) @ProfTimNoakes: In fact @HPCSA_ charge when read properly doesn't indicate that use of social media was an issue. Just said "on social media". If concern had been that the information was conveyed on social media, charge should have made the separate statement that it was "AND on social media"

Analysis:

Noakes uses Twitter to highlight breakdowns in communication/miscommunication.

4.2.39) Tweet 44 and analysis

17 Feb 2018

Quote tweet:

"I signed to protect Noakes, other people challenging conventional wisdom, & to enable the health of humanity. In the name of free speech! @ProfTimNoakes Stop the harassment of Prof.. Tim Noakes - Sign the Pe... http://chn.ge/2EGpf3p"

44) @ProfTimNoakes: If we lose, implications very interesting. Persons registered with HPCSA would henceforth be unable to provide any medical or scientific information to general public in any form − written, spoken etc. Dietitians to give information only as part of doctor-referred medical consult

Analysis:

Noakes believes the implications of potentially losing to the HPCSA are far more complex than people can imagine. He is vocal about his thoughts and opinions.

4.2.40) Tweet 45 and analysis

20 Feb 2018

Quote tweet:

"#Urgent! This week, S. African officials are appealing their own 2017 acquittal of Prof. Noakes. Again they allege that #LCHF is not "evidence-based." Petition of MDs says YES, there is science for #LCHF. PLEASE #RETWEET, SIGN AND SHARE http://chn.ge/2BATF8F @Change #keto"

45) @ProfTimNoakes: We're on the cusp of 11 000 signatures. Let's keep going (please).

Analysis:

Noakes used Twitter to spread a petition to collect signatures to support the claim that there is evidence-based science for the LCHF diet.

4.2.41) Tweet 46 and analysis

22 Feb 2018:

Quote tweet:

"Stay strong @ProfTimNoakes we're behind you all the way! #NoakesAppeal"

46) @ProfTimNoakes: One more day to go. Should be all over by 13h00 tomorrow. Then we await verdict of Appeal Committee. In court their position has already been stated − there was no doctor-patient relationship. Which logically means that I have no case to answer. But will that be final decision?

Analysis:

Noakes used Twitter to keep users updated about the trial and then the appeal initiated by the HPCSA.

4.2.42) Tweets 47-48 and analysis

28 Feb 2018

47) @ProfTimNoakes: In #LoreofNutrtion, @MarikaSboros and I draw attention to the bigotry, the bullying and the betrayal behind this @HPCSA_ @ADSA_RD trial. This is not the way that a civilised (civilising) profession should conduct its science. Or address disagreement in its practice.

Quote tweet:

"He set himself up for it???? So bullying is OK then in your world. Because spending a fortune on a bad prosecution seems ridiculous and unwarranted to me."

48) Noakes: In #LoreofNutrtion, @MarikaSboros and I draw attention to the bigotry, the bullying and the betrayal behind this @HPCSA_ @ADSA_RD trial. This is not the way that a civilised (civilising) profession should conduct its science. Or address disagreement in its practice.

Analysis:

Noakes uses Twitter to promote his other projects as well.

4.2.43) Tweet 49 and analysis

13 March 2018

Quote tweet:

"For anyone who wants to see the poor quality of science in #LoreofNutrition, please read"

49) @ProfTimNoakes: I'm sure your discerning followers will want also to read our responses to your "review" of our bad science. Here they are: From myself http://bit.ly/2E5nAVC ; from @MarikaSboros http://bit.ly/2DAV4dD . Let's reiterate point that you have yet to publish a peer-reviewed article

Analysis:

Noakes uses quotation marks whenever he wants to make it clear that he does not believe in the legitimacy of a concept or in this case, review by medical scientist Alistair McAlpine (2018).

4.2.44) Tweet 50 and analysis

20 March 2018

Quote tweet:

"What I find hard to understand is why carb restriction is so emotive."

50) @ProfTimNoakes: "Outbursts of emotional hostility from progressive activists..(SJWs)..have come to be known as getting 'triggered'..activists have adopted it to describe the anxiety and discomfort they experience when they are exposed to views with which they disagree". http://bit.ly/2DFzQdT

Analysis:

SJW refers to the concept of "Social Justice Warriors", also known as trolls, who get "triggered" (i.e. affected or bothered by) certain topics or individuals. These users prefer to argue online because they do not have to confront their opponent(s) in person. Noakes shares information concerning the psychology of trolls rather than ignoring them.

4.2.45) Tweet 51 and analysis

3 April 2018

Quote Tweet:

"We were following a lioness carrying her cub & she was getting really tired. An elephant showed up wanting to help the lioness. The elephant put its trunk down, the cub jumped up & the elephant carried the lion cub!! S28, 3km from S entrance. Tinged by Sloof Lirpa"

51) @ProfTimNoakes: Who can explain this?

Analysis:

Noakes shares a picture of wildlife and asks his audience to engage with him on the topic, even though it has nothing to do with health or nutrition.

4.2.46) Tweet 52 and analysis

3 April 2018

Quote Tweet:

"I know what they were eating - gels, biscuits, coke, nutella sandwiches, and crisps from aid stations (no ffq required!) - I was eating them alongside at one point too, so no - facts not bias."

52) @ProfTimNoakes: What @CocaColaCo has achieved so effectively and seemingly effortlessly is to brainwash us all into believing that if you're physically-active running marathons and ultra marathons, eating junk food is just fine. I believed it too. I developed T2DM as a result. Don't believe it

Analysis:

Noakes will call out brands or people if he thinks they are responsible for "brainwashing" the public. "Brainwashing is so powerful" (Noakes, 2018).

4.2.47) Tweet 53 and analysis

6 April 2018

53) @ProfTimNoakes: RIP South African cricketer 1961-66 Colin Bland from Zimbabwe. He revolutionized the art of out-fielding in cricket. Showed the Power of the Individual who saw what no one else had ever seen before him. And acted to turn his vision into reality.

Analysis:

Noakes shares information that gives some insight into his personal interests and hobbies. This particular tweet serves as a reminder that Noakes is originally from Zimbabwe as well.

4.2.48) Tweet 54 and analysis

18 April 2018

54) @ProfTimNoakes: Congratulations @kylebuckingham for converting to LCHF/Banting 15 months ago. Fourth in @IRONMANtri SA in 2017 and now First. Best wishes for more great races in the future.

Analysis:

Noakes will tweet examples of successful individuals/athletes who follow his diet.

4.2.49) Tweet 55 and analysis

25 April 2018

Quote Tweet:

I don't see much change in this having just completed studying sports science at UG level. One lecturer was a world-class body-builder & strength researcher but all the others had a background in endurance sports of team sports. Next to zero understanding of strength & muscle.

55) @ProfTimNoakes: Until 6 months ago I was equally guilty. Fortunately @CrossFitCEO, @CrossFit and coach @tyronhatch have been educating me since then. But took me 52 years to get over the idea that CV endurance is all that humans need to be healthy. And I'm usually considered an early adapter!

Analysis:

Noakes will admit – albeit not always on Twitter − when he has been wrong in the past, even in contexts that are unrelated to his nutritional advice, such as CrossFit (a form of exercise).

4.2.50) Tweet 56 and analysis

25 April 2018

Quote Tweet:

"Professor, I think you are a hero for making your stand in court! So much easier to deal with Trolls on Twitter than Trolls in Court. And yes, your lawyer was good! Just from my vantage point watching this movie. Stay strong!"

56) @ProfTimNoakes: None of my Trolls bothered to hear our testimony - apparently too much pseudoscience for these Einsteins and Oslers. Yet in cross-examination over 4 days, we conceded only 1 point - I misread a graph, confusing gestational age. Prosecution utterly unable to dent any LCHF evidence

Analysis:

Noakes points out that none of his trolls listened to his testimony in the HPCSA hearing. He admits where he has made a mistake and feels frustrated that others won't do the same.

4.2.51) Tweet 57 and analysis

4 May 2018

Quote Tweet:

@ProfTimNoakes has any affects been noted with LCHF diet on cancer patients?

57) @ProfTimNoakes: 2 topics that doctors discuss on social media at great personal risk − vaccination and treatment of cancer. One's safe from trolls only by making statements that support vested pharma interests. Growing evidence that LCHF has role in cancer treatment as supplement to standard care

Analysis:

"You cannot talk about vaccines or chemotherapy without being destroyed and your reputation ruined" (Noakes, 2018). Although Noakes is bold on social media, he remains cautious about certain topics.

4.2.52) Tweet 58 and analysis

7 May 2018

Quote Tweet:

"How about this thought, that the council is just going to let it all hang in the wind, not disclosing, hoping for a crack to appear, because they did not get the answer they wanted? It is a form of political poison."

58) @ProfTimNoakes: Worst case scenario for @HPCSA_ would be if Appeal Committee ruled correctly (as my legal team proved) that it was malicious prosecution based on collusion between @DietitianClaire and HPCSA Board Member well BEFORE contentious Tweet was sent.What if Committee also awarded costs?

Analysis:

Noakes is transparent about the appeal so that users can remain informed throughout the process.

4.2.53) Tweets 59-60 and analysis

17 May 2018

59) @ProfTimNoakes: All apologies will be graciously accepted. It's time to move on. Hopefully @HPCSA_ Appeal Committee will make the correct call and allow us all to focus on healing the nation's health.

Reply:

"Generously put, Tim."

60) @ProfTimNoakes: I genuinely mean it. So many have been hurt in the process- not least @DietitianClaire - that it's time to close that chapter. Science has moved on dramatically in 4 years. No longer reasonable to argue that LCHF is not THE lifesaving treatment for those with insulin resistance

Analysis:

59-60) Noakes admits that he would accept an apology from the HPCSA but rather wants to focus on the future of health and nutrition in South Africa. His tone could be interpreted as being falsely humble or possibly even gloating. However, in the face-to-face interview, Noakes (2018) expressed that he genuinely wants to put the hearing "behind" him so he can move on with his life and focus on his goals.

4.2.54) Tweet 61 and analysis

19 May 2018

61) @ProfTimNoakes: Perhaps one of most emotional moments of my academic life. I arrived here by so many chance events, directed by forces I do not understand, supported by my own group of special heroes. To all those who shared their love, inspiration, wisdom, courage, belief, this is also for you. [Attached video of Noakes receiving standing ovation at a conference in London].

Analysis:

"People know that I will own up to my mistakes because they've got the history to prove it. I have a talk in London recently and got a 4 minute standing ovation just by the way, which you can see because someone filmed it. I got it because I said I was wrong and owned up to it. You have to be meticulously honest all the time."

4.2.55) Tweets 62-63 and analysis

21 May 2018

Quote Tweet:

"I feel the same about Michael Moseley, but all I can see out of that conference is this kind of self-congratulatory bollocks, and that's not how science works - there seems to be a total lack of scepticism and criticism, which is normal at a conference and what moves sci forward."

62) @ProfTimNoakes: You weren't present. I asked many of audience why they were so moved. They said: "Because you were prepared to admit your errors". Sounds like they respect my scepticism and willingness to criticize myself and the conventional dogmas that are killing us. Actually I'm the sceptic

Quote Tweet:

"I'm curious because I was involved (both a participant and researcher) in carbohydrate loading studies in the 80s and 90s; then taught my students about carbohydrate loading pre and post exercise, because those were the ACSM recommendations at the time!"

63) @ProfTimNoakes: Still are as far as I know. So you must be doing what is right and true (sarcasm). No one ever tells us that the skeletal muscles of the insulin-resistant (the majority to recreational athletes IMHO) have ++reduced capacity to store glycogen. Instead they store carbs as liver fat

Analysis:

62) Noakes will defend himself when users criticise him, especially those who criticise him without using evidence-based arguments to do so.

63) Although Noakes often uses a sarcastic tone, he puts (sarcasm) to indicate that he is being sarcastic, so that his intention is clear.

4.2.56) Tweet 64 and analysis

22 May 2018

64) @ProfTimNoakes: .Strange that my Twitter address suddenly morphed overnight from @ProfTimNoakes to @noakes_prof. I had nothing to do with it. Seems to be functioning at present but if any strange Tweets should appear, please understand that they might be from a hacker. At present none such

Analysis:

"My account was hacked a few days ago. Someone changed my access name. I think they were trying to access my other accounts to buy books from Amazon. They didn't do anything to my Twitter. No one sent out "rude" tweets" (Noakes, 2018).

4.2.57) Tweet 65 and analysis

28 May 2018

Quote Tweet:

"Why did @ProfTimNoakes get a standing ovation?

http://www.zoeharcombe.com/2018/05/phc-conference-2018/ …

Also featuring @PeterBrukner @BJSM_BMJ @DrAseemMalhotra @lowcarbGP & more…"

65) @ProfTimNoakes: Thanks @zoeharcombe - with @bigfatsurprise and @CarynZinn, The Three Angels in my @ADSA_RD @HPCSA_ Trial. Add in my wife Marilyn and @MarikaSboros, and two female members of the Professional Conduct Committee and you have 7 quite remarkable women. Who could ever ask for more?

Analysis:

Noakes refers to the women that supported him as his "angels" and acknowledges that he couldn't function without his team.

4.2.58) Tweet 66 and analysis

30 May 2018

Quote Tweet:

"The reaction you create is beyond me. 2 friends Profs in Biochemistry at UCL UK and 2 at Wits med school expressed ad hominem put downs when I mentioned you and LCHF that left me speechless. But thanks from 2nd edition Lore of Running to Lore of Nutrition - lost 18kg no TIA's"

66) @ProfTimNoakes: The real sadness is that the generations of students for whom they are responsible will only know the truth if and when they discover it for themselves. That's not a great academic legacy.

Analysis:

Noakes will share tweets that praise him but will respond in a way that redirects attention from himself and instead on the greater cause he has dedicated his life to working on.

4.2.59) Tweets 67-73 and analysis

8 June 2018

67) @ProfTimNoakes: @ADSA_RD @HPCSA_ trial finally over: "..it is the unanimous decision of the members of the appeal committee that the appeal be dismissed. It is so ordered". We won!! Thank you LCHF World for your support which never wavered. @MisterPikester @bigfatsurprise @zoeharcombe @CarynZinn

Quote Tweet:

"Is this official???????????"

68) @ProfTimNoakes: Yes. Yes. Yes. There were 3 issues in dispute before Appeal Committee - 1. Protection of public. 2. Doctor-patient relationship. 3. Tweet was/was not unconventional advice. Appeal Committee ruled in our favour in all 3 decision. So final count is 13-0 in our favour. It's over!

Quote Tweet:

"4 years of patience, hard work and truth. In my view, the equivalent of a World Cup won by #LCHF in the medical fraternity, captained by @ProfTimNoakes - the authentic, gracious, selfless scientist of the century. This is not the end, but the beginning of a health revolution."

69) @ProfTimNoakes: Thanks so much @Habib_Noorbhai Privilege to know you and to learn from you. You are correct - there is still so much to do

Quote Tweet:

"OMG! I could not be happier. Well done @ProfTimNoakes @MisterPikester Rocky & Mike @bigfatsurprise @CarynZinn & @MarikaSboros & Marilyn! We did it!"

70) @ProfTimNoakes: Thanks so much @zoeharcombe for your crucial contributions to ensure the innocent verdict. But there is one bit of business still to be completed - our exposure of the Naude meta-analysis http://bit.ly/2oRXgpJ Awaiting final response from #UniversityStellenboschHealthSciences

71) @ProfTimNoakes: We won! Thanks so much @MisterPikester #BrotherRockyRamdass #MikevanderNest for making this indescribable moment possible. It took 4 years; thousands of hours of work; millions of rands; all of it now worthwhile. May this never ever again happen to another South African medic

72) @ProfTimNoakes: Official position of @UCT_news appears to be that by questioning any role of commercial influence on academia including the direction of @UCTHealthSci research and teaching, I simply got what I deserved. So we're dealing with fixed hierarchy, unwilling to consider novel ideas.

9 June 2018
Reply to tweet:
"Noakes added that he, along with his wife, had chosen to fight the hearing "because we knew that what we are saying is the truth, and in the end the truth will always win"."

Reply:
"Nutrition is so important. This is a huge victory. @DietitianClaire, how does it feel to be on the wrong side of history and lose?"

73) @ProfTimNoakes: @DietitianClaire could still do a Mea Culpa as I did and take @ADSA_RD and her profession along the high road. Failure to do that could weaken Nutrition and Dietetics beyond recovery. It is a critical moment in the history of that profession. Will require extraordinary leadership

Analysis:
67-73) Noakes announces that he won the appeal and replies to users that congratulate him. He his honest about the fact that it was tough but reminds his audience that he will continue to fight what he believes to be an important battle.

4.2.60) Tweet 74 and analysis

13 June 2018
Quote Tweet:
"So why is saying someone is overweight "fat shaming" then? It's simply a statement about a physical characteristic that doesn't actually show any ill will towards the person."

74) @ProfTimNoakes: Funny this. Former fatties (like myself) come up to me daily to thank me (and I suspect myriads of other LCHF doctors) to thank us for "saving their lives". Somehow I think we've done more to reverse the stigma of obesity than any other group of doctors in history of medicine.

Analysis:

Noakes uses language that might be considered offensive to some but he uses it within context of his own personal experiences, and not for shock value purposes.

4.2.61) Tweet 75 and analysis

25 June 2018

Reply to tweet:

"Hi @ProfTimNoakes I'm writing something about the Keto diet, are there any estimates about how many people are following it worldwide?"

75) @ProfTimNoakes: In South Africa the #Banting7DayMealPlanFacebook page has >1.4 million members @xeyedmess and there are similar pages in Nigeria with ~1 million members. This is not a small insignificant movement either in Africa or globally.

Analysis:

Noakes takes the time to respond to questions from other users.

4.2.62) Tweets 76-80 and analysis

25 June 2018

76) @ProfTimNoakes: Finally I understand psychology of trolls. Called gaslighting http://bit.ly/2Kq4vU1 "Gaslighting is a form of persistent manipulation and brainwashing that causes the victim to doubt her or himself..ultimately lose her or his own sense of perception, identity, and self-worth https://www.psychologytoday.com/us/blog/communication-success/201704/7-stages-gaslighting-in-relationship"

Reply:

"I actually think it's different from Gas Lighting Prof..... sure some similar traits but people get a sense of power behind a keyboard they often would never have in person. They hide behind a persona and an identity and just get a kick out of causing drama."

77) @ProfTimNoakes: I think it's more than that. I've seen off 5 or more trolls who may indeed have been that way and who eventually lost interest. But the persistent ones (>2 years) are very different.

Reply:

"Im sorry to hear that.... I guess in a general population we are made up of all types of personalities. Some of these trolls are very narcissistic by nature... and there will of course be the psychopath and sociopath out there too. Try to remember it's their problem."

78) @ProfTimNoakes: The ones I really take exception to are the medical doctors. No question in my mind that trolling a medical colleague is utterly unacceptable professional behavior that should be actioned by professional bodies.

26 June 2018

Quote Tweet:

"'Internet Trolling and Everday Sadism' - there is probably something much deeper and more troubling at play. https://onlinelibrary.wiley.com/doi/abs/10.1111/jopy.12393 …

79) @ProfTimNoakes: Our trolls are sadists, @MarikaSboros. "Conclusion: Results confirm that online trolling is motivated (at least in part) by sadistic tendencies. Coupled with effective rationalization mechanisms, sadistic pleasure can be consummated in such everyday behaviors as online trolling"

28 June 2018

80) @ProfTimNoakes: Silence is often the kindest response.

Analysis:

76-80) Trolls have been a major issue for Noakes. He compares trolls to mentally and emotionally unstable people who use Gaslighting techniques to manipulate other people. He is very vocal about his experiences with and opinions of trolls. "They [the trolls] all make demeaning comments which are not true. They are not experts in nutrition like I am" (Noakes, 2018). Noakes admits that silence is often the best way to handle trolls yet he also feels the need to defend himself as much as he can – which is perhaps an example of contradictory behaviour between what he says in person and how he acts on Twitter.

4.2.63) Tweet 81 and analysis

29 June 2018

81) @ProfTimNoakes: Make history. Be a participant in one of the most important nutrition studies of our time. @davidludwigmd https://twitter.com/davidludwigmd/status/1012060033885134854

Analysis:

Noakes encourages his audience to get involved in research that has the potential to impact their own lives.

4.2.64) Tweet 82 and analysis

13 July 2018

Quote Tweet:

"It's the cultural shift away from experts (and towards social media influencers) that has got us into so much trouble in all areas. Years of training, research, experience mean nothing to many and so we have the era of every tine believing their opinion is equally valid…"

82) @ProfTimNoakes: I notice this especially amongst current generation of medical students who have grown up with social media. They tolerate the teachings of the Anointed because they have to - to pass exams. But they are also cognizant of The Wisdom of the Crowds @TomDNaughton from social media

Analysis:

Although Noakes points out the problems associated with social media, he maintains that it is vital to make use of it as it allows for decentralised communication. However, in the face-to-face interview, Noakes mentioned a commencement address given by his friend Tom Naughton, who "talks about the wisdom of the crowds versus the power of the anointed." According to Noakes (2018) the so-called anointed are professors at university because they disseminate "handed down wisdom, which is not tested in science." Noakes expects the public to be critical of wisdom that is handed down yet he himself has a following of people who look up to him. When asked what makes the information he shares true, Noakes (2018) explained that "if it [his diet] doesn't work then the crowds will discover it."

4.2.65) Tweet 83 and analysis

16 July 2018

Reply to tweet:

"It could be victim mentality. I also think that the "pharmafoodicalcomplex"'has done a good job of demonizing ("quack" "not approved by FDA, ADA, AHA) any cure that doesn't require a prescription or that eliminates processed food & drinks."

83) @ProfTimNoakes: Indeed. Those who engineered the campaign to have me declared a 'quack' refuse absolutely to look at the many examples of failure of the pharmacological model of chronic disease and the damage caused by treating patients exclusively according to that model.

Analysis:

Noakes will point out when he feels he has been victimised by other academics, trolls or the media.

4.2.66) Tweet 84 and analysis

Quote Tweet:

"Think about all the resources that sick people require late in life. If you can stay healthy until you die, you are helping the planet"

84) @ProfTimNoakes: And the stress on the families of those dealing with family members with chronic diseases. No one ever talks about this. We have a responsibility to spare our family members from that unnecessary outcome.

Analysis:

Despite being accused of being a controversial figure, Noakes continues to make controversial statements in an attempt to get people to engage with topics, even if they are uncomfortable.

4.2.67) Tweets 85-86 and analysis

17 July 2018

85) @ProfTimNoakes: Taxi driver (no training in biology) casually informs me that he lost 96kg (192 to 96kg in 18 months). So I ask: How did you do it? "Oh, I just Googled Banting and read your book. Stopped eating sugar and bread. No longer fear fat. Just took some discipline". What's so difficult?

Reply to tweet:

"Changing habits, managing stress to curb cravings, dealing with relational and emotional aspects of eating. It's difficult and much more than discipline. If you want people to try this diet they must feel understood. Questions like "what's so difficult" only isolate many people."

86) @ProfTimNoakes: My question was for scientists who claim that there's no evidence that "diets" ever work in anyone. Just wish that sometimes they'd escape the academic Ivory Tower and confront reality. That would really help their world view. And their science. And ultimately their relevance

Analysis:

85-86) Noakes is critical of "handed down wisdom, which is not tested in science. It is I said it so therefore it is true and it doesn't work. And if it doesn't work then the crowds will discover it" (Noakes, 2018).

4.2.68) Tweets 87-88 and analysis

21 July 2018

87) @ProfTimNoakes: "At least anecdotally, it seems that the carnivore diet is extremely effective in relieving joint pain". If you have osteoarthritis you can help test this theory by participating in trial run by @SBakerMD. Help disprove the anecdotes or turn anecdotes into preliminary evidence

25 July 2018

88) @ProfTimNoakes: The rapid rise of "fake" science. Predatory journals pose a massive threat to the integrity of science https://www.icij.org/blog/2018/07/new-international-investigation-tackles-fake-science-and-its-poisonous-effects/

Analysis:

87-88) Noakes shares articles that are relevant to the scientific community as well as the general public.

4.2.69) Tweets 89-90 and analysis

28 July 2018

Quote Tweet:

"No evidence base behind LCHF? I'd say some of the worlds leading researchers would disagree. I was only in Vienna last week at the European Congress on Obesity where Prof. Arne Astrup noted how LCHF was the best treatment for T2Diabetes"

89) @ProfTimNoakes: Enormous respect for Prof Arne Astrup who has changed his mind on diet http://bit.ly/2K38p0t http://bit.ly/2uW85fy vs stated beliefs just 18 years ago http://bit.ly/2va25iw

30 July 2018

Reply to tweet:

"I agree. As a med student we are taught from the same old books. Not always bad, but some new ideas wil help the profession to grow"

90) @ProfTimNoakes: Thanks @waldovn96 The professors I admired in my training were those who lectured from the scientific journals, not from the textbooks. They were the one's challenging dogmas and looking to explain causation. That's what education should be about. Not rote learning.

Analysis:

89-90) Noakes makes his opinions clear and is not afraid to speak his mind.

4.2.70) Tweet 91 and analysis

Quote Tweet:

"A few comments in this thread reveal unbelievable straws the "Tim Haters" will grasp to try and discredit him. Guessing they are fortunate enough to not suffer from the ailments that Tim has helped >100,000(?) people overcome so fail to understand where he ic coming from"

91) @ProfTimNoakes: My choice is to provide individuals with information that may help them better understand their health and how to sustain/improve it. If some don't like that choice then, you know what? They really don't have to read anything I tweet. Then we'd all be better off.

Analysis:

Noakes admits that he doesn't understand why trolls feel the need to bombard him with messages when they could choose to ignore him and his theories.

4.2.71) Tweet 92-93 and analysis

24 Aug 2018

Quote Tweet:

"Seeing is definitely believing. I experimented with LCHF, &only started prescribing it when I experienced the lifestyle &benefits for myself. No amount of trials could have convinced me prior to this. From the outside, LCHF seems extreme. From the inside,it makes perfect sense"

92) @ProfTimNoakes :From leading South African endocrinologist who's jumped ship on dietary advice for persons with T2DM. It takes great courage to put principles (helping cure patients) before concerns about personal consequences including professional bullying and exclusion. Praise to @Tasneem_iX

27 Aug 2018

93) @ProfTimNoakes: In hindsight, @deb_cohen was the first to expose the influence of sugary drink industry on the scientific process and formulation of drinking guidelines for sport. Some years before the work of @GreenPlusAnE , @anahadoconnor and @CrossFitCEO exposed an even wider collusion

Analysis:

92-93) Noakes will give credit when it is due.

4.2.72) Tweet 94 and analysis

Quote Tweet:

"My daughter is a dietitian from the Free State University and is a firm believer of Keto after studying ir and research. She is so scared to come out cuz the HPCSA will stop her from working."

94) @ProfTimNoakes: I think you'll find it's @ADSA_RD and other influences on @HPCSA_ But my trial proved that LCHF diet is evidence-based disproving @ADSA_RD @HPCSA_ position. According to @MisterPikester this is legal precedent for South Africa. We fought this battle for 4 years for your daughter

Analysis:

Noakes will tag the HPCSA AND ADSA [Association for Dietetics in South Africa] to get their attention and remind his audience that he will continue to challenge these institutions, even though he won the hearing and the appeal.

4.2.73) Tweet 95 and analysis

Quote Tweet:

"Wow. 8 min-video. The 17-year long editor of JAMA admits he was completely wrong on nutrition. WE were completely wrong. Public health, universities, medical community created diabesity pandemic by misunderstanding dietary fat, obesity, metabolism"

95) @ProfTimNoakes: Why is that we old guys have to be well beyond 60 years old before we can see the truth and finally have the courage to expose the Medical Crime of the Millennium? Needs to start in the training of our medical students. No longer any time to waste.

Analysis:

Noakes' tone implies a sense of urgency, which could be interpreted as unscientific by those who criticise Noakes for rushing to publish his findings.

4.2.74) Tweet 96 and analysis

29 Aug 2018

Reply to tweet:

"The peer review process closes science to critical independent thinking. Science has become a religion + any independent thinker is soon burnt at the stake of heresy. Any such religious science should immediately be questioned due to its dogmatic stance which inhibits natural law"

96) @ProfTimNoakes: As we @MarikaSboros describe in #LoreofNutrition. Peer review exists to protect the accepted dogmas. I describe it also in #ChallengingBeliefs and #Waterlogged. The latter was 1st time I experienced how industry can "direct" peer review process in major (sports) science journals.

Analysis:

Noakes uses Twitter to promote his books and highlight topics that wants users to take notice of.

4.2.75) Tweet 97 and analysis

Reply to tweet:

"I think people get confused by the constant mixed messages and contradictions. For a long time red meat was demonized as we're many things."

97) @ProfTimNoakes: The constant mixed messages are part of a global campaign of mis-information funded by the industries producing cheap processed high carb, high cereal/grain "foods". It's only going to get worse. We have to develop a novel strategy to compete with their decades' long campaign.

Analysis:

Noakes' tone and language is urgent and direct, as he feels that people are not taking him seriously.

4.2.76) Tweet 98 and analysis

29 Aug 2018

98) @ProfTimNoakes: All great med advances begin as anecdote. Smallpox vaccine (Jenner);cholera elimination (Snow); antisepsis (Lister); antibiotics (Fleming/Chain); Helicobacter causing GI ulceration (Marshall/Warren); disproof of lipid hypothesis (patchy nature of arterial disease - still to come!)

Analysis:

Noakes addresses criticism that he relies on anecdotes by arguing that "all great medical advances begin as anecdotes" (Noakes, 2018).

4.2.77) Tweet 99 and analysis

Reply to tweet:

"LOL @ProfTimNoakes if peer review is so bad why are you in academia? And I've never had peer reviewers try to 'suppress' my research... rather they tried to make sure that it was suitible for publication. I believe you are confusing 'independent thought' with 'talking BS'"

99) @ProfTimNoakes: That's because you've never challenged convention.

Analysis:

Despite claiming to not care what trolls have to say, Noakes will respond to tweets that he feels are trying to challenge him.

4.2.78) Tweet 100 and analysis

30 Aug 2018

Reply to tweet:

respectfully, challenging convention doesn't necessarily mean being right. It only means being opposed.

100) @ProfTimNoakes: So far I've been right 7 times out of 7 as documented in my books #ChallengingBeliefs, #Waterlogged and @LoreofNutrition. There are the facts.

Analysis

Noakes believes in his cause wholeheartedly because he is confident that he has evidence to support all his claims.

Upon analysing the two hundred combined tweets published by Berger and Noakes, this researcher shall, in the following chapter, summarise the key similarities and differences between these scientists.

Chapter Five: Discussion and Conclusion

5.1) Discussion

In this final chapter the results of the analyses of the one hundred tweets by Lee Berger and one hundred tweets by Tim Noakes will be discussed and analysed further. Based on the content analyses and information gathered from interviewing Berger and Noakes – telephonically and in person – the following insights were deduced:

Berger:	**Noakes:**	**Both:**
Tone is generally lighthearted	Tone is usually serious and can be interpreted as blunt/harsh at times	Honest
Will often post jokes or other humorous content	Focuses on using Twitter to read articles posted by other academics and to defend himself and his own work when criticised	Transparent
Remains calm and does not engage with as many trolls as Noakes does	Is not afraid to initiate and/or deal with conflict online	Use hashtags (#) and tag other users to increase visibility
Uses different kinds of technology to give his audience a holisitic and engaging idea of what it is he does for a living	Is retired and has more time to use social media	Inclusive
Tries to make science fun and exciting	Has had to respond to more criticism than Berger	Acknowledge their support systems
		Give credit when it is due
		Keep their audiences regularly updated
		Believe information should be decentralised
		Point out when the media and/or critics are not providing evidence-based arguments or relying on reputable sources
		Respond directly to as many tweets as possible
		Never use swear words or derogatory language
		Have mostly different, yet sometimes similar methods of dealing with trolls
		Link their audiences to information that is relevant and/or interesting
		Admit that they do not know everything
		Will ask questions
		Call out inaccurate information/"fake science" that is circulating Twitter
		Have loyal followers who will interact on behalf of them when they are being criticised

5.2) Conclusion

Overall, there are more similarities between how the two scientists use Twitter to communicate. The most prominent feature of Berger and Noakes' approach is that they − despite pressure from colleagues, the media, and the public − choose to remain as honest as possible. Neither Berger nor Noakes believe that they have done anything wrong and therefore, have nothing to hide, which is why they do not hesitate to be transparent on social media. Instead, they hope that their open, honest, and confident style of communication will help to inform, educate and sometimes even (particularly in Berger's case) entertain their audiences and perhaps attract more users to follow them as well.

Inclusivity is a major recurring theme for Berger and Noakes; both are determined to make their information accessible, as they know how it feels to be singled out or excluded (most certainly Noakes more than Berger) for being controversial (Joubert & Guenther, 2017). Noakes has had to endure intense public scrutiny, which is why – as hypothesised at the beginning of this investigation – his tone on Twitter is more serious and defensive than Berger's, in general. Although Berger was also accused of pseudoscience, he is not as defensive or confrontational as Noakes is online. He does not have as many trolls to deal with and if he does, tries to avoid interacting with them if he can. Noakes claims to do the same but will often engage with criticism because 1) he has more time to do so and 2) he takes personal offence to criticism that is not "backed up by evidence" (Noakes, 2018).

However, while Noakes might engage with criticism more than Berger does, it should be noted that he does not resort to using derogatory language or swear words. His vexation is implied by his tone and sometimes, if he wants to make it very clear, by written cues such as (sarcasm) or quotation marks. The same can be said about Berger, for he too avoids foul language on Twitter. Noakes (2018) also suggests that since he has been acquitted of all charges related to the HPCSA hearing and appeal, he hasn't had to deal with as many trolls because they "lost interest" in challenging him.

Similarly, both scientists do their best to respond to questions from other users – be it laypersons, professionals or other members of academia. They will direct their audiences to information that might be of interest or share links to other scientists' work or projects that they think are worthwhile. Berger and Noakes embrace the idea that science is a "team" effort that requires collaboration from a variety of different players. They do not believe in working in isolation and will both give credit to the people that support and/or inspire them. They also do not believe that they know everything and are not ashamed to ask questions if they need to.

There is a subtle interplay between being assertive and being humble. This researcher believes maturity and experience play a role in developing a person's ability to find a balance between moving forward in a confident

manner whilst remaining unpretentious. However, age should not deter young people (and in this case, scientists) from trying to learn from the older and more experienced individuals such as Berger and Noakes, so that they can apply their techniques sooner rather than later.

Further study is needed to make sense of how certain individuals navigate visibility and public relations in a constructive way. Berger and Noakes were chosen to be the focus of this particular study because they were found to be the most visible scientists in South Africa. However, they are not the only visible scientists from South Africa and they are both men, which means that there is room to investigate how publicly visible female scientists, as well as younger scientists and scientists of different races and ethnicities – who might be visible in the imagined Twitter community but not yet have academic visibility – use Twitter to communicate. There are many layers that need to be explored in order to help us better understand how to use modern technology to advance the decentralised scientific cause.

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